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CHEMICAL & METALLURGICAL ENGINEERING

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"Executives Are Urged to Co-operate"

PROMPT return of monthly oil refinery figures would materially improve the production reports issued by the Bureau of Mines. This fact is the occasion for the request made by that bureau recently from which the title of this editorial is quoted. The bureau well says that "there is need for prompt co-operation, in view of the great value of these data to the oil refiner," for it is the industry itself which profits or loses according as the results are complete and promptly available, or incomplete and late.

Moreover, this is not an isolated case in which co-operation of industry with government investigations is important. At the present time the Bureau of the Census is making its biennial survey of the manufacturing industries. The results of that survey will be of tremendous importance to business, particularly to each business from which statistics are gathered. Co-operation with the census is therefore very important to business itself.

Reliable statistics are tools of great importance in planning production, distribution or sales. A knowledge of recent and current market prices is of no greater value to an industry than similar current data of production, distribution or stocks on hand. Where such figures are not already being gathered industry should set about having them made accessible promptly. And in the meantime those who are getting more or less belated returns now should see to it that the laggards in their industry speed up in order to permit quick, complete reports within those fields already covered either by government or association work. The value of the statistics is greatly enhanced by promptness, and the co-operation or lack of co-operation by the industry itself will altogether determine this factor.

The Strain Of War

PHYSICAL tests of army officers which have lately been in progress show "the most clear-cut evidence of physical deterioration" due to the "strain incident to the prosecution of the world war." It is found that they suffer from "instability of the nervous system," "an unnatural tendency to worry, fatiguability, low blood pressures and a lowered resistance to infectious disease," and that they show a "tendency toward increased introspection and mental exaggeration" of all forms of worry and mild physical ills. Blood pressures are abnormally high in men over 45, and among younger officers of 25 to 30 it is abnormally low.

What else should we expect? War is and always has been a debauch of anger. Active war experience is replete with shocks due to insomnia, muscular exertion, emotional excitation and physical injury. According to Dr. GEORGE W. CRILE of Cleveland, these cause histological changes in the brain, the suprarenals and the liver, and while some of his conclusions as to the wounding of the brain by shock have been questioned by his colleagues, we know that, in the main, experiences of this sort do cause injury, and these medical examinations prove it.

There has been a terrible let-down in reasonableness all over the world. Such instability of the nervous system, unnatural tendency to worry, chronic introspection and exaggeration of all sorts of ills do not apply to army officers alone. It is far more general. We have, all of us, been under great strain, and many of us are not over it yet. Some of us are permanently injured.

War upsets the mental balance, injures the understanding and the effectiveness of both victor and vanquished. History offers a leading example to which we have paid too little attention, because it was our own European forbears who did the damage. The Arabs maintained a wonderful civilization in Spain and Portugal. Their gardens were gardens of delight, and the remnants of their architecture indicate a cultivation and development that was far beyond that of any part of Europe for many centuries. It is among them that we find the beginnings of science as distinguished from abstract philosophy. We know but little of GEBER —but in chemistry we begin with him. The Arabs were also physicians and astronomers, and they gave us our numbers.

Then we good Europeans took up the white man's burden, and we drove the Arabs out. We disagreed with them on certain points of what is sometimes called "revealed truth" and we routed them utterly. We got into the habit of fighting them and hating them. And we conquered their proud spirit. We killed all those wholesome doubts within them which are the very foundations of science and which lead to inquiry and thought. We drove them back to their own traditions —and they have been living on them ever since; intellectually living on nothing but traditions. We spoiled them for a thousand years.

How much of their chemistry did we take from them? Nothing but the cheapest, easiest necromancy; the get-rich-quick foible of turning baser metals into gold. Why hadn't we better taste or more discrimination in our stealing? Because the wars had injured us white folks very much as they had injured the Arabs. For over half a millennium we were a low-lived lot.

When ERASMUS, with his great vision, saw the possibilities of chemistry and induced PARACELSUS to study it, the stage was set for progress, but there was still so much war going on, with its pernicious sequelæ, that the result was far more quackery than honest research. Even old GLAUBER used to sell love-potions.

And it was not until the seventeenth century that ROBERT BOYLE made chemistry the profession of a gentleman.

The big war has hurt everybody, victors and vanquished. We've all gone off in our competence, our understanding, our level-headedness. We're excitable, nervous, hysterical. Look at the United States Senate, the House of Representatives, at every parliament in existence! The members behave like wayward children. Honest debate has become almost a lost art. It is time to steady ourselves and to think straight. We have big jobs ahead of us and we are not ready for them. One of these big jobs is for us white folks to get along together, to understand one another, to stop yelling and to be decent as well as sensible. Army tests during the draft indicate that 40 per cent or more of the people of the United States do not develop mentally above the age of 10 or 12 years. Some of these children occupy high offices and they prove the fact every day.

Be a Good Neighbor —It Pays

THE man who has a job in a factory or plant located in a suburban section usually considers himself fortunate, for the surroundings are pleasant and comfortable and working conditions in general much more agreeable than in congested locations in the heart of a city. The residents of such suburban districts, on the other hand, usually do not welcome factories for next door neighbors, and often with good reason. However, under modern conditions with up-to-date ideas of how to operate a plant, the objections to most types of factory are rapidly disappearing. One of the largest factors in this change is the approved method of boiler and power plant operation which is now possible.

No one likes to live next door to the proverbial boiler factory. The noise from such an establishment is, of course, quite objectionable. But it is no less objectionable to the housewife to live near a beautiful factory building artistically designed and surrounded by beautiful lawns if the power plant of the establishment belches forth black smoke and spots the clothes on Monday and soots up curtains and furnishings all the rest of the week. Proper boiler design and operation will eliminate this factor without difficulty.

There is no reason, with modern equipment and modern methods of firing, for making any objectionable quantities of smoke or dirt. Coal can be received and ashes removed without serious nuisance to surrounding buildings or residences. The smoke or gases from the stack can be made quite unobjectionable. In other words, there is no reason why the power plant of any commercial establishment should cause the institution as a whole to be an undesirable neighbor.

If those who are planning and those who are operating will bear these facts in mind they can contribute their part toward more satisfactory plant locations. And with more satisfactory plant location will come better satisfied operatives. Everyone from the president in his mahogany-furnished office to the stoker or ash handler will enjoy being in a neighborhood where a few lawns and a few trees are possible instead of only brick alleys and the congested backyards of the factory district. It will pay well for the power plant to make itself a good neighbor.

Are Technical Editors Timid?

THE other day a manufacturer friend of ours told us that he did not think the editors of technical papers were courageous. When we asked him to be specific, he stated that, as a class, we were afraid to publish the facts about a new development unless it had been thoroughly tried and proved successful. As an example, he told of a new application of his company's product, which has been made at the request of a customer. This has been carefully worked out from an engineering standpoint and has been tried experimentally, but as yet has not been put to practical use. Our friend thought that under the circumstances we would not be willing to give the matter any editorial attention.

This is indeed far from the facts. We wonder how such misconceptions arise and how far they spread. One of the prime functions of a technical paper is to present the news of its field. Naturally, nothing can be published without sufficient examination to convince us that the principle involved is sound and that the source of our information is reliable. But when we can obtain news of a worth-while attempt to advance engineering practice, our first duty, provided the originator is willing, is to pass the information on to our readers. Often we are enjoined to secrecy. When publicity is earnestly sought it is too often for its advertising value.

No, our friend is mistaken. When he is ready to give us permission to do so, if we find his new development of interest to our readers, we shall be willing and glad to bring it to their attention.

Railroad Earnings And Service

THE new practice of considering economic questions quantitatively may well be applied to the so-called railroad problem. It may be putting it rather strongly to say that the old-fashioned "political economy" represented theory, while quantitative economics represents facts, but the difference is of that character, at any rate.

A report is now available for the full calendar year 1921 as to the earnings of the railroads, the net railway operating income having been $614,810,531, while 6 per cent on the tentative valuation (a trifle under 19 billion dollars) would be $1,115,940,000, according to the computation of the Bureau of Railway Economics. Thus the rate actually earned was 3.31 per cent. In the first 2 months of the year there were deficits, earnings then increasing to a maximum of 5.01 per cent for August, and dwindling thereafter to a rate of 3.44 per cent for December.

In this question of where railroad rates should be fixed, therefore, there is an amount of money involved, to be paid by the public or to be saved by the public, of less than half a billion dollars a year. No one states any definite figure, hence it is necessary to guess the amount of money folks are talking about, using as a basis the figures cited above.

The National Bureau of Economic Research last year studied the income of the American people for the years 1909 to 1918 inclusive, and found the income in 1913, the last pre-war year, to have been about 35 billion dollars, while for 1918 it was 61 billion, the increase being due chiefly to the advance in prices, for

the bureau concluded that the 1918 income reduced to 1913 dollars would be about 39 billion.

Merely the roughest sort of guesses are sufficient to reduce the present question to a quantitative basis. As such guesses we may take 40 billion as the present income and 50 billion as the income if business were "good," as those who wish railroad rate reductions argue would be the case if the reductions were made. Taking the 50 billion, one finds that the outside amount at stake in the rate discussion is 1 per cent of the national income.

From the quantitative viewpoint, therefore, the question is whether an amount of money equal to 1 per cent of the national income can have much effect upon the conditions that produce the income. One is entitled to have doubts. It is argued, however, that high freight rates interfere with certain kinds of business, and it may properly be claimed that it is unfair to set the half billion dollars against the whole 50 billion. However, a scrutiny of ton-mileage freight movement and railroad revenue in 1921 does not indicate that the heavy and low-priced commodities suffered more than the very valuable commodities, in which freight rates cut little figure. Some heavy commodities, like coal and iron ore, had a restricted movement in 1921, but it could scarcely be shown that a mere reduction in freight rates would have produced a normal movement.

Further objection to the quantitative comparison may be made, that even if freight rates are not vital from the money standpoint, their remaining unliquidated has a bad psychological influence. That is another story, and there may be something in it, though scarcely a great deal.

On the other side of this question is the matter of railroad service. Greatly increased business activity in the United States cannot be expected if the railroads cannot handle the accompanying movement, and there is impressive testimony that the railroads as now physically constituted cannot stand any great increase in load.

From that angle the question is whether the people can spare something like 1 per cent of their income as insurance against a transportation breakdown in case business tries to become very active.

How Things May Look In a Hundred Years

WE CHILDREN OF LIGHT of these days are not so very wise, after all! Let's imagine ourselves living in 2022, and discussing in some library rich in contemporary documents the economic history of the first quarter of the twentieth century. One of our number might pick up an advertising brochure of an important chemical manufacturing concern dated 1922.

"Here's an interesting note!" he might exclaim. "It is a chapter headed 'Publicity Harmful,' and the vapid excuse given is that if it were known that they were busy in the development of any product, before they were making enough to supply all who ask for it, some one customer might gain an advantage over another. As an actual reason it is so frail that it is funny, but it is of value as showing that they recognized the need of some sort of an excuse for their secrecy.

"Secrecy was the bane of chemical industry in those days. The dye industry, for instance, was having a hard time to get started in the United States. Before the Great War Germany had practically a monopoly, and during the war there was pressing need to produce, although the Americans were without intermediates, except aniline. You'd think, with a whole industry eating its heart out for intermediates, for beta naphthol, H acid and a whole string of others, that they would have made common cause in research, wouldn't you? But that wasn't the way they did things in those days. The Sherman act threatened them with all the thunders of the law if they did not compete in selling. Any co-operation was thought to be dangerous, whether it was or not. And this worked against public interest, because its effect was to discourage manufacturers from working together to reduce their costs. There was really nothing to hinder them except that it was contrary to tradition.

"Tradition ruled throughout most branches of chemical industry. Everything was locked up tight in front with a constant but slow leakage going out of the back doors, while chemists were often actually forbidden to exchange ideas with other chemists. The veil of commercial tradition still covered nearly all kinds of manufacture. Why, do you know there were some concerns that used to pay $50,000 a year for legal advice and $5,000 a year for scientific guidance in chemical industry!" The speaker would then probably have to prove that he was not joking.

Another might refer to the farmers of the Middle West, who burned corn as fuel because they could not dispose of it, while millions were starving in Russia for lack of that very corn and many hundreds of steamships were laid up in idleness with plenty of coal available and seamen out of work. "That tragedy," it might be remarked, "was due to the fact that they were so tied up by system that they could not count anything but dollars. Not one man in ten thousand knew calculus or could integrate."

"Still another tragedy of those days," one of the company might say, "was the Lesser Antilles. Those jewels of the sea, the loveliest places on the globe—that LAFCADIO HEARN wrote about, for instance, in his classic 'Two Years in the French West Indies,' where everything will grow, where nobody need starve, where the sea swarms with fish, where both summer and winter breezes are the balmiest that blow—were practically out of use. Sugar in the lowlands could not compete with Cuba and Porto Rico; coffee in the uplands could not compete with Brazil, and the trade in citrus fruits was held elsewhere. It was not a question of costs; it was a question of facilities and transportation and co-operation and thought. All this time the natives were gradually drifting back to the condition of savagery that reigned in Haiti and Santo Domingo. The most beautiful islands in the world were relegated to the rubbish heap. "

"What was the matter?" one might ask.

"Well," another might reply, "my theory is that the principal trouble of those days was a curious delusion in which men undertook to do business as though they were lawyers trying a case in court. Everybody strove to put his competitors into a hole—and nearly everybody succeeded. It was the lazy way, to succeed by a trick. They hadn't learned the rule for industrial success: to aid the industry in which you are engaged by every possible means, to scorn secrecy as bad form and as the weapon of the incompetent, and then to have wit enough to keep ahead of the game. Only a few men engaged in industry had seen this light in those days."

Then we should all agree that the ways of 1922 were pretty crude.

Readers' Views and Comments

Electrolytic Iron a Commercial Product

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the article appearing in your issue of Jan. 18, page 128, "Electrolytic Iron a Commercial Product." This is extremely interesting, but I notice a statement at the bottom of column 2 of the article as follows: "For example, the circulation of the electrolyte, always maintaining it up to the desired standard of iron content . . . This is the novelty introduced by Frederick A. Eustis and Charles P. Perin." This I would point out is not novel. The utilizing of certain ores as raw material is, of course, beneficial and presents no difficulty. The precipitation of the copper, if any, by the usual and well-known method can also be easily effected.

The difficulty, of course, is not in any of these things, but principally in maintaining the electrolyte neutral on a large-scale plant and producing iron without the aid of trick methods free from hydrogen craters—every time.

Davenham, Cheshire, England. S. HUTCHINS.

An Outline of the Uses of Lime

To the Editor of Chemical & Metallurgical Engineering

SIR:—The article under the above caption in your issue of Feb. 15 is likely to give rise to false impressions in the paragraph on stucco. This would give the idea that lime was added purposely to sorel cement, whereas it is an absolutely undesirable impurity and usually results in the quick disintegration of the sorel cement containing it.

This is recognized in the article by Messrs. Seaton, Hill and Stewart in your issue of Aug. 17, 1921, where they give the following tables:

TABLE I—EFFECT OF LIME CONTENT, AS DETERMINED BY ADDITION OF LIME

No. Lime added	Tensile Strength, Lb. per Sq.In. 3.70%	2.69%	1.68%	0.67%
1	329	364	486	826
2	328	320	470	653

TABLE II—EFFECT OF ADDITION OF $Ca(OH)_2$ TO CALCINED MAGNESITE

1 part magnesite, 2 silex, 5 sand, by weight, 22 deg. Bé. $MgCl_2$

Per Cent $Ca(OH)_2$	Tensile Strength Lb. per Sq.In. 7 Days	30 Days
0	490	882
1	397	562
3	347	473
6	150	247
10	207	230

and as noted in the same article was earlier discussed by Rourke.

In percentages a little greater than those tested by Mr. Seaton—that is, from 5 to 10 per cent of active CaO—I have had entire test briquets disintegrate into pieces not one of which would be more than ¼ in. along the edge. In smaller percentages the test briquets would swell and twist without actual disintegration and would become moist and soft in damp weather, even after standing 6 months.

Similar bad effects are caused by the use of excessive amounts of calcium chloride in the magnesium chloride solution with which sorel cement is set, or by the presence of large amounts of calcium chloride in the dry powder for water mix stucco. DONALD M. LIDDELL.

New York City.

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the points brought out in Donald M. Liddell's letter on the article "An Outline of the Uses of Lime," I wish to state that the use for lime which we had in mind in connection with the manufacture of sorel cement was not the addition of lime to the cement but the use of a dolomitic lime as the base for the cement. This is a subject which has received a great deal of investigation in many places and was the subject of a paper read by J. B. Shaw at the spring meeting of the American Ceramic Society in 1921. The subject of this paper was "New Developments in Oxychloride Stucco and Flooring." The process described consists of burning dolomitic lime at a temperature at which the calcium carbonate is not decomposed. The product is then treated with alkaline earth chloride solutions.

I believe it is generally agreed that the addition of lime to sorel cement, as ordinarily made, is not advisable. M. E. HOLMES,

Washington, D. C. Manager, Chemical Department, National Lime Association.

Cost of Analyses in State Laboratory

To the Editor of Chemical & Metallurgical Engineering

SIR:—The statement on page 521 of your March 15 issue showing the cost of chemical analyses made by the State Department of Chemistry, Harrisburg, Pa., is truly a most interesting one. If we analyze this statement we find that 2,876 complete analyses of a variety of materials are handled at a cost of $13,689.76, which expense covers overhead, rent, light, etc. This is an average of 9 samples per day, and if we assume 5 determinations per day at a total cost of approximately 90 cents per determination, as compared with a charge of $4 per determination made by the commercial chemist.

In view of the fact that it is our earnest endeavor to produce dependable analyses by well-trained and well-paid chemists, at the lowest possible price to our customers, we are at a loss to understand why we (the commercial chemists as a class) are compelled to charge four times the price for the same class of work as J. W. Kellogg, inferring that he is applying the same labor and overhead expenses which the commercial analysts must bear. If possible, we should like to pass on to our clients in the form of lower prices benefits of any information as to reducing expenses. At the same time it must be understood that we are not eleemosynary institutions and that a small profit at least must be allowed us.

We surely hope that more detailed statement as to the activities of the Pennsylvania State Department of Chemistry would not prove as disappointing to us as the reported profits covering the operations of the Emergency Fleet Corporation.

NEW YORK TESTING LABORATORIES,

New York City. L. R. SEIDELL.

A New Point of View

To the Editor of Chemical & Metallurgical Engineering

SIR:—Having just read the Dec. 14, 1921, issue of your journal, I am very much astonished at the tone of the article headed "Haber, Nernst and the Amenities of Life." This article is in fact an insult against the eminent men who are members of the Svenska Akademien, an institution whose position above the hatred between nations which resulted from the war absolutely cannot be questioned. If the Svenska Akademien has seen fit to grant the Nobel prize to the great inventers Haber and Nernst, you can be assured that this has been done, not because their inventions have been used partly in chemical warfare, but because these inventions have served and will further serve mankind in the work for progress.

Your journal is remarkable for its often repeated hateful articles against Germany. When Germany was forced into the great war by aggressive Russia, I cannot understand why the Germans should not have the right to fight! But the Germans were far ahead of you in applied chemistry in all its branches, and that is possibly the cause for your campaign against them at all suitable and unsuitable times. I remember that some months ago you published an article against Germany, because that country made an attempt to apprehend the three chemical engineers (and only partly succeeded in it) who had been bought for money by the Americans to steal the secrets about some dye products of value to you and to cross over the sea with these papers or samples. I am sure, for myself, that it had been better for you not to mention that dirty affair at all. If you are such masters in chemistry, why did you engage the men to betray their country and their firm?

Domnarfvet, Sweden. HAROLD ALMQVIST.

It should be needless to add that our comment was in no sense intended as "an insult against the eminent gentlemen who are members of the Svenska Akademien." Our correspondent offers a novel and hitherto unpublished explanation of the cause of the late war. Evidently much depends upon the point of view.—EDITOR.

The Composition of Pine Oil

To the Editor of Chemical & Metallurgical Engineering

SIR:—In connection with the discussion between L. F. Hawley and C. M. Sherwood regarding the composition of pine oil, the accompanying chart may be of interest. This chart has been compiled from a study of the literature, including Schimmel & Co.'s semi-annual reports and the Forest Service bulletins, as well as the chemical periodicals. In this chart we have listed all the compounds we could find reported as found in oils obtained by steaming pine wood.

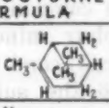
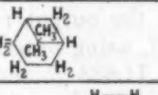
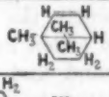
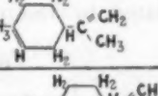
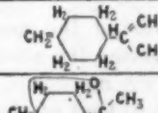
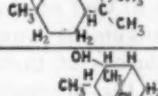
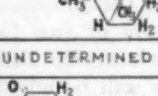
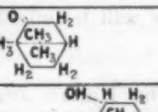
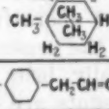
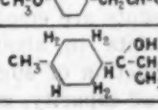
A consideration of the structural formulas of these compounds suggests that the terpineol might be derived from the dipentene by addition of water, and that the dipentene was an intermediate step between the alpha-pinene and the terpineol. Similarly the nopinene might conceivably rearrange to gamma-terpinene and the addition of water to the latter give rise to the cineol.

We should be very glad to have your readers' criticisms of this chart, as we feel that the subject is worth considerable study and discussion.

JOSEPH H. WALLACE & CO.
By R. H. Stevens, Chemist.

Stamford, Conn.

COMPOUNDS FOUND IN OIL FROM PINE

	NAME	BOILING POINT DEG. C.	MELTING POINT DEG. C.	SPECIFIC GRAVITY	REFRACTIVE INDEX	EMPIRICAL FORMULA	STRUCTURAL FORMULA
In Gum Spirits of Turpentine	α-PINENE	155-156		0.863/15°C.	1.4678/15°C.	$C_{10}H_{16}$	
In Gum Spirits of Turpentine	β-PINENE (NOPINENE)	162-163		0.874/15°C.	1.4724/15°C.	$C_{10}H_{16}$	
In Steam Distilled Wood Turpentine	CAMPHENE	160	50	0.850/48°C.	1.4851/48°C.	$C_{10}H_{16}$	
In Steam Distilled Wood Turpentine	d-LIMONENE, l-LIMONENE, RACEMIC ISOMERS DIPENTENE	175		0.849/15°C.	1.4710/15°C.	$C_{10}H_{16}$	
In Intermediate Fraction	γ-TERPINENE	179-181		0.847/20°C.	1.48458/20°C.	$C_{10}H_{16}$	
In Intermediate Fraction	CINEOL	176	-1	0.930/15°C.	1.4584/20°C.	$C_{10}H_{18}O$	
In Pine Oil	FENCHYL ALCOHOL	202-203	33-35	0.933/58°C.		$C_{10}H_{18}O$	
In Pine Oil	ISO-FENCHYL ALCOHOL	202-203	61.5	0.9613/15°C.	1.48005/20°C.	$C_{10}H_{18}O$	UNDETERMINED
In Pine Oil	CAMPHOR	204	175	0.985/15°C.		$C_{10}H_{16}O$	
In Pine Oil	BORNEOL	212	204			$C_{10}H_{18}O$	
In Pine Oil	METHYL CHAVICOL	215		0.9710/15°C.	1.51726/15°C.	$C_{10}H_{12}O$	
In Pine Oil	α-TERPINEOL	218	35	0.9391/15°C.	1.48132/20°C.	$C_{10}H_{18}O$	

Note: Names in heavy type are the chief components

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENOA, Italy, March 8, 1922.

DURING the last 5 weeks the different branches of the Italian chemical industry have been affected by the following economic factors: (1) The continued scarcity of electric power, which has been only in part compensated by the use of oil and gas engines and steam motive equipment. (2) The continued rise in the value of the Italian lira, which has caused considerable loss among the different producers and merchants, especially those who are dependent upon foreign raw materials. (3) The rise in the price of coal. (4) The diminishing demand for chemical products, due to financial difficulties and the smaller purchasing power of the consumers. And (5) the imminent danger of a strike in the principal chemical factories. Most of the works in the tartaric acid, citric acid, dye and heavy chemical industries have refused to continue the present wage scales, such as were arranged during last November. The strike will not be general, however, since the owners of the india rubber factories, the fertilizer works and the match plants have decided to continue their present policies as regards wages.

SULPHUR INDUSTRY

During February there was a continuation of the campaign for a reorganization of the sulphur-mining industry in Sicily. It is hoped that the purchase of new mechanical equipment will serve to relieve the difficulty caused by the very crude methods of mining, as well as the lack of adequate transportation facilities. Some improvement in the industry has been noted since the organization of the Anglo-Sicilian Co.; however, this company took possession of only one-third of the sulphur mines in Sicily, and in the remaining two-thirds conditions remain practically unchanged. In 1916 the sulphur industry employed 11,732 workers and the output reached 1,672,571 tons of sulphur. In 1917, using practically the same equipment and employing 11,688 miners, production decreased considerably. Recently the prices for the different sulphur products have fallen to new low levels due primarily to the small demand and to the large stock which had been accumulated by the producers.

TARTARIC ACID INDUSTRY

During the month the Italian Chamber of Deputies discussed the advisability of increasing the export taxes on raw materials, in order to raise the price of tartaric acid to that of the various foreign manufacturers. This arrangement would, of course, benefit the few Italian producers of tartaric acid and cream of tartar. However, the proposition was seriously opposed by the exporters of raw tartar and by the wine producers, and it is scarcely believed that any increase in the export duty will be effected.

SUGAR INDUSTRY

The Italian sugar industry normally employs about 5,000 operatives in its thirty-eight sugar works. During the season in which the beets are harvested, which usually lasts from 60 to 80 days, 15,000 additional peasants are employed. The capital invested at present amounts to about 374,000,000 lire, and the annual production of sugar, when all the plants are operating at full capacity, is about 300,000 tons. During the past year, however, only about 205,000 tons was produced, notwithstanding the fact that the country consumed 250,000 tons. The reason for this is that only 74,000 hectares was cultivated for beets during the past year. There are nine sugar refineries in Italy, two of which are independent, while the others are controlled by the beet growers. Although at present there is a manufacturing tax of 2,161.50 lire per ton, and also a duty of 360 lire gold, it is possible to import foreign sugar at a price approximately equal to that of the product manufactured in Italy. It has recently been stated that a number of sugar works will be compelled to remain closed, if the government does not make some change in the present customs treatment of sugar.

PETROLEUM INDUSTRY

The dearth of water power has stimulated the search for petroleum in the different parts of the Italian Kingdom. It is reported that new deposits have been discovered in the Emilia region and that large resources were disclosed at San Giovanni Incarico, at Pico, in the Liri Valley. It is further stated that considerable resources are known to exist on the isle of Sicily.

FERTILIZERS

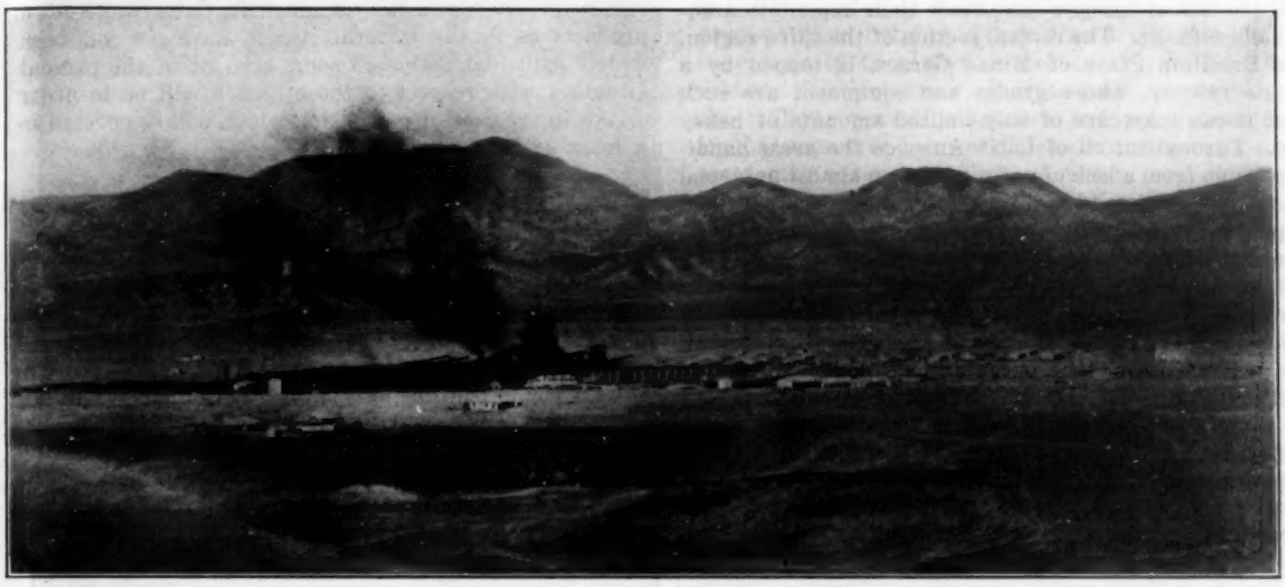
The rise in the value of the Italian lira and the small demand on the part of consumers have resulted in considerably lower prices for fertilizers. The season is already well advanced, and the stocks, especially those of nitrate of soda, are quite large and further cargoes are expected to arrive. For this reason additional reduction in the price of fertilizers is already foreseen. Sulphate of ammonia continues in good demand and it is stated that it is practically impossible to fill all of the orders. Germany continued to prohibit the exportation of sulphate of ammonia and all that could be secured came from either the United States or England. Ammonium nitrate could have been sold to good advantage, but very little was offered. The situation in regard to superphosphates remains unchanged. Imports of rock phosphate during last October reached 42,537 tons, as compared with 23,865 tons during the same month of the preceding year. During November the imports were only 21,834 tons, as against 25,983 tons in November, 1920.

METAL IMPORTS

The Italian imports of metals during September reached 832 tons, during October 644 tons, and during November 5,434 tons. These, however, are considerably less than the imports in the corresponding months of 1920, when 11,512 tons was reported for September, 3,399 tons for October and 7,320 tons for November.

Swiss Demand for Copper Sulphate

Considerable quantities of blue vitriol are required in Switzerland for the spraying of the vines. Imports fluctuate between one and three million kilograms a year. In 1919 Great Britain supplied Switzerland with copper vitriol valued at 1,000,000 francs, or two-thirds of the total supply, but in 1920-21 Germany was the chief supplier. At the present time copper vitriol is a state monopoly in Switzerland. Free imports, however, would make the vitriol about 2,000 francs cheaper per truck, so that the abolition of the monopoly is demanded. It is probable that the monopoly will be abolished very soon.



COPPER MINE AT CHUQUICAMATA, CHILE

Minerals, Earths and Clays of Latin America—I

The First of a Series of Three Articles Describing the Mineral Resources of Latin America and Analyzing the Economic Factors on Which Their Development Is Dependent—Chilean Nitrates, Tin, Copper, Iron, Gold and Silver Are Discussed*

BY OTTO WILSON
Former Chief, Latin-American Division, Department of Commerce

FROM the earliest years of exploration the countries of Latin America have been associated with the production of mineral wealth. It was partly in search of precious metals that Columbus and his successors set sail, and after such metals were found a continuous stream of them flowed across the Atlantic for 300 years. Their production meant slavery and death for great numbers of Indians, but at the same time it furnished the chief impetus to the settling of the territories south of the Rio Grande. Gold and silver are still mined to the extent of many millions of dollars annually, and silver, because of the Mexican output, continues to be one of the leading Latin-American minerals. But both are now recovered to a very considerable extent as byproducts in the mining of other metals, and in the last 30 or 40 years other minerals have passed them in total value of output.

The World War was particularly effective in stimulating the production of the so-called base metals, and the high prices during the war and immediately thereafter acted as an "open sesame" not only to many abandoned workings but also to entirely new sources of supply. The more recent fall of prices in turn relegated most of these new workings again to the wilderness, but they may be considered as an important part of the world's known reserve, to be drafted into service again whenever a special need arises or whenever the demand shall be sufficient to meet the costs of mining and transportation. These costs, so far as great areas are concerned, are prohibitive in normal times and will probably continue so largely because the mountainous mineral country is still so sparsely settled.

Dearth of Transportation Facilities

Of the three great mineral regions into which Latin America may be roughly divided—(1) Mexico and Central America, (2) the Andean and neighboring highlands, and (3) the rich Brazilian field centering in Minas Geraes—only the first can be said to be even fairly well provided with railways. Furthermore this is true only of parts of Mexico and is not at all true of Central America. The second region, extending along the entire western coast of South America, possesses the advantage of being near the seaboard, but this is partly offset in Colombia, Ecuador, Peru and Bolivia by the fact that the mines are found in the highest mountain country in either of the Americas, sometimes 10,000 to 15,000 ft. above the sea. This plateau region has been penetrated by only a few railways—viz., one leading up from Guayaquil to Quito in Ecuador, two or three others in Peru, and finally the two in northern Chile which furnish an outlet to Bolivia. Many of the rich Chilean mines lie in or near the lower coast ranges, and they are the most accessible of all South American mines, but even here the desert nature of the country

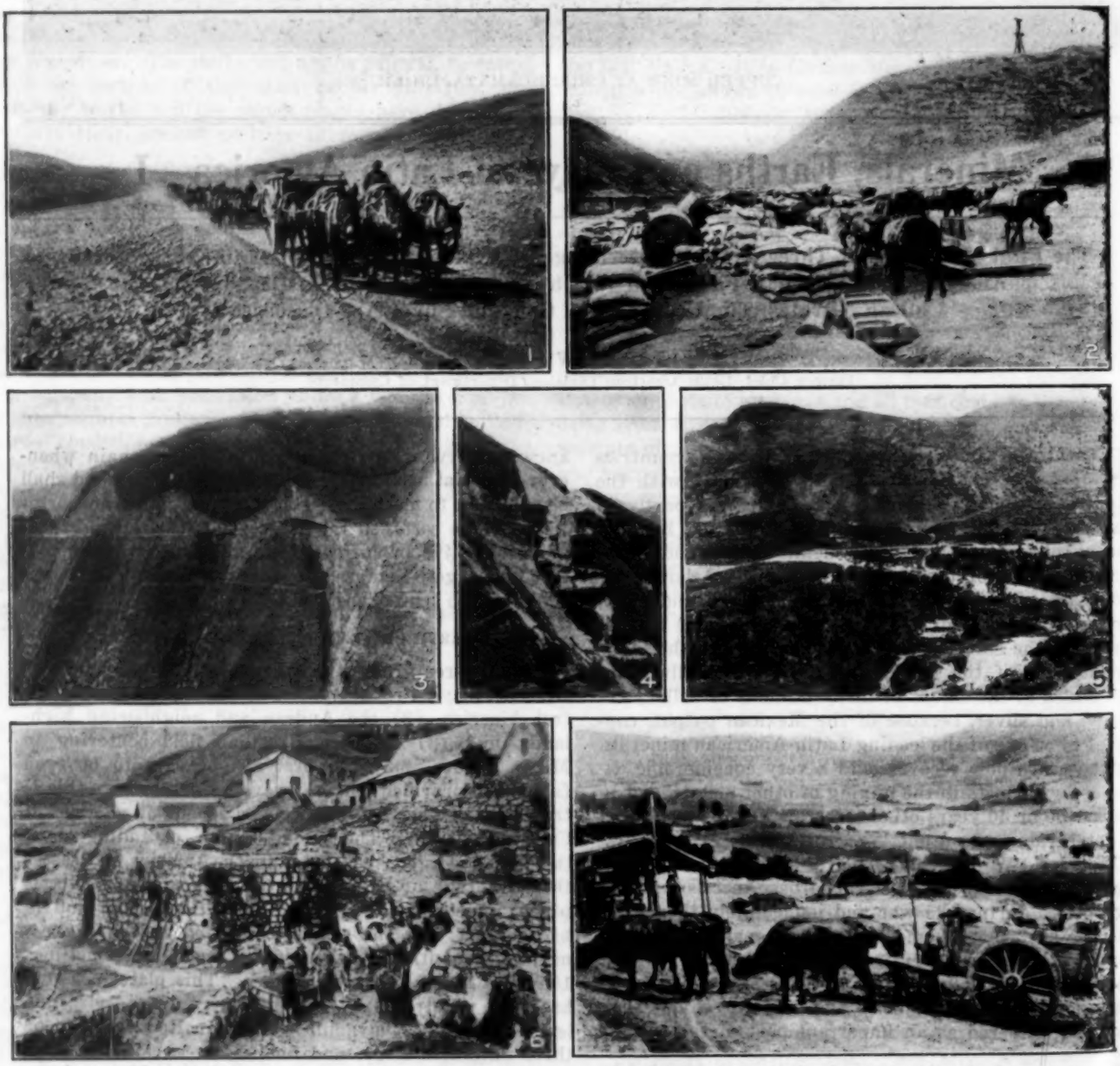
*The photographs for this series of articles were furnished by the Pan-American Union, Washington, D. C. For ore analyses, many figures of production and other detailed information the writer is indebted to "Mineral Deposits of South America," by Miller and Singewald, and to "Political and Commercial Geography," edited by J. E. Spurr. Both volumes are published by the McGraw-Hill Book Co., Inc.

and the lack of harbors have made their exploitation unusually difficult. The central section of the third region, the Brazilian State of Minas Geraes, is tapped by a single railway, whose grades and equipment are such that it can take care of only limited amounts of heavy ore. Throughout all of Latin America the great handicap, aside from a lack of railroads, is an almost universal absence of roads and highways. Mining machinery and supplies can be taken in and ore brought out only at great expense except in the few localities reached by the railways. Inadequate transportation thus prevents the working of many high-grade deposits, and as with other lines of South and Central American development, the exploitation of the mineral wealth must await the railway and modern means of transportation.

In point of total value the chief minerals which Latin America contributes to the world's markets are Chilean nitrates, copper, petroleum, silver and tin. The present review is interested not so much in these well-known products as in the minerals which have not yet been widely exploited, although some account of the present situation with respect to those named will be in order except in the case of petroleum, which will be covered in a later article.

The Chilean Nitrate Industry

Of all the varied products of the earth which Latin America yields, the one which constitutes the greatest source of wealth is in many respects the most curious. The nitrates of Chile form the only large deposit of such material in the world. They are invaluable both in peace and in war, furnishing a necessary constituent of fertilizers for peace-time agriculture and an equally essential constituent of explosives. In Chile this tremendous source of national wealth lies near the surface of the ground as a stratum of a barren, treeless and almost



FIGS. 1 TO 7—TRANSPORTATION DIFFICULTIES IN CENTRAL AND SOUTH AMERICA

Fig. 1—Carting tin ore to the railway in Bolivia. Fig. 2—Copper ores arriving at railway station, Corocoro, Bolivia. Figs. 3 to 5—New construction of Amagá Railroad in Colombia. Fig. 6—Llamas bringing copper ores to the mills in Peru. Fig. 7—Transporting coal from Colombian mines.

FIG. 8—OPEN COPPER ORE WORKINGS AT COROCORO, BOLIVIA

rainless desert, extending for about 500 miles over the northern end of the country. The layer of nitrate varies from a few inches in thickness up to 12 ft., the average being perhaps 2 ft. It is loosened by blasting, and is prepared for shipment at local officinas or factories, of which there are about 175. Extraction usually takes about 20 to 24 hours, and the amount of nitrate actually recovered has in the past been only about 70 per cent, although more economical processes are now being introduced. The cost of producing and shipping a ton of nitrate in normal times, when the price runs about $44 at a North Sea port, has been estimated as follows: Production cost, $13.10; export duty, $11.92; transportation, $4.17; commercial expense and profit, $14.88. Exporting has been going on for a hundred years and has now reached a level of 3,000,000 tons a year, valued at a round $150,000,000. The life of the fields depends partly on how low a grade of nitrate may be worked, but estimates of 200 years are held to be conservative.

At the beginning of the war in Europe the Chilean nitrate industry was stagnant, and scarcely recovered during the succeeding year. But the war demand for nitrates for explosives and the clearing of the seas of German raiders brought the industry back to its former prosperity, and in 1918 exports, standing at 3,289,325 tons, were above normal. Since then the history of the industry has been one of ups and downs. In 1919 there was another heavy slump, followed by a great gain in 1920, but again by a severe depression in 1921. The supplies in Europe are controlled by an organization known as the Pool, and the Chilean exportation is almost wholly in the hands of a producers' association. On Oct. 27, 1921, an agreement between these organizations was reached by which prices are fixed until July, 1922, and this is expected to stimulate exports and relieve the depression. Early in March, however, it was reported that conditions in Chile during the first 2 months of the year were still quiet, awaiting an improvement in the movement of nitrates. Exports in 1921 were 1,100,000 metric tons, as compared with 2,750,000 metric tons in 1920.

Copper Mining and Its Latent Possibilities

This same region of northern Chile is the site of another mining industry which in value of output may in a few years surpass even the nitrate fields. Many years ago Chile led the world in copper production. She dropped back, but in the last 5 or 6 years she has advanced again to a position second only to the United States. Her enormous reserves make it possible that she will yet pass this country and again become the leading source of the world's copper. American capital amounting to tens of millions of dollars is being invested in development works, mostly by three companies, the Chile Copper Co., the Braden Copper Co. and the Andes Copper Co. The first-named has at Chuquicamata the largest known copper deposit in the world, its positive and probable ore, with the percentage of copper, being as follows at the beginning of 1921:

	Short Tons	Per Cent
Oxidized ore	329,306,106	1.91
Mixed ore	151,000,000	2.98
Sulphide ore	210,000,000	1.84

In the latter part of 1921 the monthly production was about 4,000,000 lb. of copper, about half the 1918 average.

Throughout northern Chile there are hundreds of small mines, many of them containing ores of high copper percentage. Some have been slightly worked and abandoned because of the heavy cost of transportation, and there appears to be a good opportunity for developing these mines if sufficient capital can be invested to meet this difficulty. The ore is mainly sulphide and oxidized ore, with some native copper. Other Latin-American countries producing copper are Mexico, Peru, Bolivia, Venezuela, Argentina and Cuba. Mexico has copper in nearly every state, but the output has been kept at a minimum by the disturbed state of the country. The biggest present mines are in Sonora and Lower California. The copper production of Mexico in recent years has been as follows: 1917, 50,986 metric tons; 1918, 70,223 metric tons; 1919, 56,172 metric tons; 1920, 46,057 metric tons.

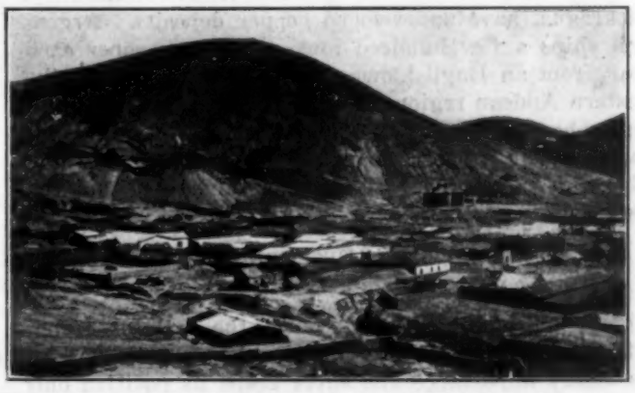


FIG. 9—SILVER MINES AT ORURO, BOLIVIA
These mines have been producers since the days of the Spanish Conquest.

In Peru two companies, both of which are now under American control, have for many years been mining copper in the high Andes and apparently have rich reserves for future working. The larger of these companies, the Cerro de Pasco Copper Corporation, had a monthly production of copper of 63,128,000 lb. in 1920, as compared with 58,124,000 lb. in 1919, 81,906,000 lb. in 1918, and 72,675,000 lb. in 1917. Bolivia has only one copper-producing section, at Coro Coro, in the central part of the country and at an altitude of 12,000 ft., where a French company mines and concentrates normally about 4,000 tons a year. In recent years, however, exportation has been much above the average, copper ore

FIG. 10—ORURO, BOLIVIA, SEEN FROM THE MINES ABOVE THE CITY

to the amount of 23,000 tons, valued at over $2,000,000, being exported in 1919. Venezuela has many copper deposits in the northern mountains, but the mining property of Aroa, worked intermittently for centuries and now owned by an English company, is the only one that has been extensively developed. The ore mined for a long while has been sulphide.

In recent years a few other copper mines have been opened, but production has been small. The copper reserves of Cuba are said to be small, but the island has recently been shipping $4,000,000 to $5,000,000 worth of ore and concentrates to the United States annually. These are the products of two mines, one near Santiago and the other in Pinar del Rio. The island of Haiti and at least one Central American country, Nicaragua, have undeveloped copper deposits. Argentina ships a few hundred tons of blister copper each year from an English-owned mine and smelter in the western Andean region, in which are several important copper-bearing localities. The ore is found in veins and much of it contains high percentages of gold and silver. Uruguay has active copper mines and undeveloped deposits.

Gold and Silver of Declining Importance Because of High Costs

Gold and silver were of course the lodestones that attracted Europeans for centuries, but gold is now of secondary importance and silver keeps its position only because of the Mexican output. This, however, is not because the deposits are worked out, but because the costs of mining and transportation are too high as compared with corresponding costs in other parts of the world. Gold is found in nearly every Latin-American country, but its leading producer is Mexico, where it is obtained to a large extent as a byproduct in the mining of copper, silver, lead and zinc. Production amounts to about $12,000,000 worth yearly, the figures for recent years being as follows: 1917, 23,542 kilos; 1918, 25,313 kilos; 1919, 23,586 kilos; 1920, 23,370 kilos.

South America now furnishes only about 2.5 per cent of the world's gold supply, the chief producer being Colombia, with $4,000,000 to $6,000,000 a year. Colombia is followed by Brazil, whose $3,000,000 annual output is supplied largely by two English-owned mines, both of which have been worked for about a century. One of these long ranked as the deepest mine in the world. Peru, Chile, Bolivia and the Guianas each produce from $200,000 to over $1,250,000 worth of gold a year. The Central American countries contribute about $3,000,000, so that the gold mines of South and Central America together may be said to produce about $15,000,000 to $18,000,000 a year.

The recent troubled times in Mexico have served to cut her normal production of silver in half. Formerly she turned out 70,000,000 to 80,000,000 oz. a year, one-third of the world's total, but in 1915 she dropped to 40,000,000 oz. and has gone lower since. In the last 3 or 4 years there has been a considerable gain, as the following figures of production show: 1917, 42,019,000 oz.; 1918, 62,517,000 oz.; 1919, 65,904,000 oz.; 1920 (preliminary), 63,600,000 oz. Bolivia, the great silver center of colonial times, still produces some silver, but is far surpassed by Peru with about 10,000,000 oz. a year. In both countries most of the metal is obtained as a byproduct, in the former of tin and in the latter of copper. Chile has had some very rich silver mines and in her whole history has produced over $300,000,000 worth of the metal, but the annual output is now less than $500,000. Colombia has been mining silver for centuries and Central America adds over 2,500,000 oz. a year to the world's total.

Tin in Bolivia

Tin in Latin America is a one-country product, Bolivia being second only to the Federated Malay States in world production. From 21,000 to 28,000 tons (tin content) is the annual output, the ore being concentrated to about 60 or 65 per cent for exportation.[1] There is a little local smelting. The value of the tin exports reached $50,000,000 in 1918. Mexico has some stream tin, and produced 9 metric tons in 1917, 13.5 tons in 1918 and 1.5 tons in 1919, but none in 1920. It is recently reported that several tons of high-grade tin ore have been discovered near Sao Paulo, Brazil, but there are no details concerning it.

These are the most valuable of Latin America's minerals as far as past and present production goes. But the list of substances of secondary commercial importance which this section of the earth holds in reserve includes nearly all the minerals known to commerce, and among them are one or two which promise to take a place of foremost importance to the civilized world.

A Steel Industry Lacking Only Coal

In that valuable group of minerals around which the iron and steel industry centers, Latin-American coun-

[1] A trade report issued by the English company J. Blum gives the 1921 shipments of Bolivian tin from the west coast ports as 17,698 tons "fine," in 60 per cent concentrates.

FIG. 11—GOLD MINING ALONG THE RIO CHUQUIAGUILLO IN BOLIVIA

tries are particularly rich. Yet in endowing them with this wealth Nature seems to have been in a rarely capricious mood. She has supplied immense stores of high-grade iron, and has thrown in the alloy metals, manganese, chromium, nickel, tungsten, vanadium, molybdenum, cobalt, titanium, zirconium, most of them in plentiful measure. But the one material which in the great steel-producing countries has been considered indispensable—namely, a good supply of coking coal—Nature has withheld entirely or has hidden away in mountainous regions so difficult of access as to remove the possibility of using the small deposits for iron smelting or steel making. There are coal deposits in southern Brazil which can be used for industrial purposes when mixed with imported coal, Chile has extensive beds of coal, and Venezuela has deposits of unknown extent, but this is nearly all lignite and is too soft and friable for coking. Colombia, it is estimated, has billions of tons of coal, some of which is hard coal, and Peru is said to have several million tons of anthracite; but in the case of the former country the difficulties of transportation are such that the deposits can serve only local uses, and in Peru the cost of mining and hauling is so great that that country imports much more than it produces. Only in Mexico can domestic supplies of both coal and iron be utilized to establish an iron industry, a good beginning of which has already been made.

The great iron fields of South America, in Brazil and Chile, may some day serve as a basis for a big steel industry, but if so it will probably be through the use of imported coke, brought back perhaps in the vessels that carry iron ore to foreign countries, or through the utilization of the water power which each of these countries has in abundance. In Chile the only serious attempt to establish a steel plant, using wood from the southern forests for fuel and carbon, ended in financial loss. In Brazil several attempts have been made, with the cordial support of the government, to establish plants for the production of steel with the aid of electricity derived from hydro-electric installations, but the cost has been found to be high. The latest enterprise of this character is one promoted by Brazilian interests, who are now erecting at Ribeirao Preto, in the State of Sao Paulo, two pig-iron furnaces, with a daily capacity of 60 tons, two bessemer converters, an electric refining furnace and two bar mills. The company expects to be producing steel by September. If this venture should prove continuously successful it would open the way to the building of other mills both for satisfying local demands and for exporting.[2]

FIG. 12—BAGGING TIN ORE FOR SHIPMENT, POTOSI, BOLIVIA

The iron countries of Latin America are Brazil, Cuba, Chile, Mexico and Venezuela, with deposits of apparently little economic importance in Argentina, Uruguay, Peru and Colombia. Brazil is the most important of all, and its fields may develop into the leading producing fields of the world, as geologists recognize the main deposits as constituting the world's greatest known iron reserve. The country is indeed a reservoir of iron, as ore has been reported from practically every state; but the section that holds the great deposits is a region about 100 miles square lying in the State of Minas Geraes about

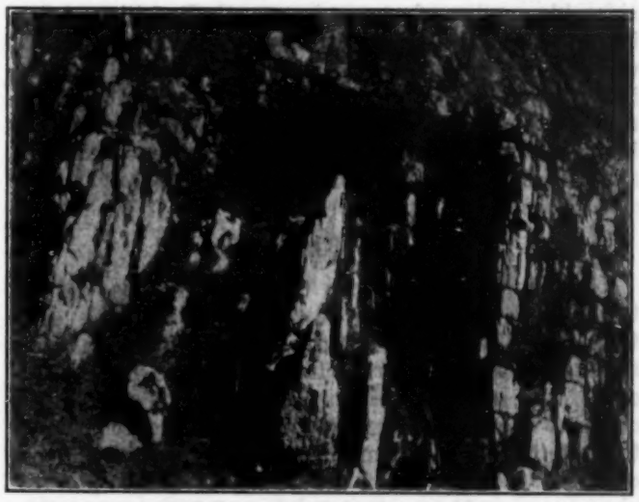


FIG. 13.—OUTCROPPING BEDS OF IRON ORE, MINAS GERAES, BRAZIL

300 miles north of Rio de Janeiro. Estimates of the amount of ore in these deposits have ranged as high as 12,000,000,000 tons, but a more conservative estimate by E. C. Harder, of the United States Geological Survey, who has made a careful study of the region, is that there are 410,000,000 tons of bessemer ores with over 68 per cent iron and less than 0.02 per cent phosphorus, and about 3,000,000,000 tons of non-bessemer ore with over 50 per cent iron and 0.05 to 0.3 per cent phosphorus. This is for the main field alone and does not include many other deposits in Minas Geraes and other states which are known to be extensive, not to mention the possibilities of unexplored territory from which iron has been reported.

The ores of central Minas Geraes are hematites, and are contained in what is known as the Itabira iron formation, the material of which is a mixture largely of fine quartz sand and iron oxide. This material, "itabirite," is itself almost an iron ore, as it contains over 30 per cent iron. The best ores are a hard massive specular hematite which is found mostly in hills and which can be mined to the extent of millions of tons with almost no waste. (See Fig. 13.) Analyses by Harder show 69.65 per cent iron, 0.0125 per cent phosphorus and 0.24 per cent silica. The soft ore contains somewhat less iron and more silica. Between the hills and on their

[2] A good résumé of the various enterprises projected for the establishment of an iron and steel industry in Brazil will be found in a pamphlet just issued by the U. S. Department of Commerce as Trade Information Bulletin 6, "The Brazilian Iron and Steel Industry."

lower slopes is often found a layer of lower grade ore known as "canga," commonly less than 10 ft. thick and containing in the better grades 50 to 60 per cent iron and 0.1 to 0.3 per cent phosphorus, of which it is estimated there are about 2,000,000,000 tons.

This region is served at present by only one railway, which runs to Rio de Janeiro and is equipped to handle only limited amounts of ore. The logical port for this field is Victoria, and its development will probably be slow until it is connected by railway with that city. This can be effected by the construction of a branch to an existing line, the Victoria-Minas Railway, and a contract for the construction of this branch, and also another branch from the same line to the port of Santa Cruz, was signed in 1920 by officials of the government and by the Itabira Iron Ore Co., Ltd., which controls large ore deposits. The iron properties are owned by a considerable number of companies, mostly Brazilian, American and English. Hematite ores are found also in western Minas Geraes, in Bahia, in Goyaz and near the inland river port of Corumbá, in the far interior. Magnetite ores are also found, the best known deposits being in the State of Sao Paulo and containing, according to analysis, 64 to 71.3 per cent iron and 0.031 to 0.041 per cent phosphorus.

Chilean and Cuban Iron Ores

The only iron ores which the continent has supplied to external commerce to any great extent have come from Chile, where the Bethlehem Steel Co. has constructed extensive works, including a harbor blasted out of the solid rock. The Tofo deposits, which that company is working, comprise an estimated 100,000,000 tons of ore, mostly hematite, which analyzes 67.5 per cent iron, 0.2 per cent manganese, 0.011 to 0.05 per cent phosphorus, 0.01 per cent sulphur, 2.5 per cent silica and 0.8 per cent titanic oxide. It is said that when all improvements are completed the company will be able to ship in the neighborhood of 1,000,000 tons of ore a year. Chile has many other scattered deposits of both magnetite and hematite.

Cuba ranks as one of the great iron countries of the world, with deposits estimated at 3,000,000,000 tons of brown hematite on the north coast and minor deposits of several million tons of magnetite and hematite on the south coast. The former ore as mined is soft and wet, and it runs, when dry, about 46 per cent iron, 0.01 per cent phosphorus, and 1.7 per cent chromium. The Bethlehem Steel Co. is the principal owner. The iron deposits of Mexico are scattered over several states. The country manufactures pig iron, the largest plant, located at Durango, producing 50,000 to 100,000 tons yearly. Venezuela has several deposits of iron, but only one has been worked. This is the Imataca deposit, near the Orinoco River, about 75 miles from its mouth. The ore is a mixed magnetite and hematite and analyzes about 66 per cent iron, 0.031 per cent phosphorus, 0.045 per cent sulphur and 0.139 per cent titanium. Argentina smelts a small amount of iron ore yearly and Paraguay is reported to have abundant ore, including magnetite, hematite and limonite, and running as high as 50 per cent iron. There is a plant at Ibicuy for working the ore.

Part II, which discusses Latin-American resources of manganese, chromium, tungsten, vanadium, molybdenum, cobalt, titanium and zirconium, will appear in a subsequent issue.

Coke Production Statistics for 1921

The first convincing demonstration that the byproduct branch of the coking industry could maintain itself in a period of industrial depression more strongly than the beehive branch was made in 1921.

In 1921 the output of byproduct coke was almost 20,000,000 tons and that of beehive coke was about 5,500,000 tons, figures that show a striking contrast to those for 1920, when the output of byproduct coke was more than 30,000,000 tons and that of beehive coke was more than 20,000,000 tons. The output of beehive coke in 1921 was less than that in any other year since 1885. The output of byproduct coke in 1921 also showed a marked decline from that of 1920, but despite the extraordinary slump in business, which greatly lowered the output of byproduct coke, it was greater in 1921 than in any preceding year except 1917, 1918, 1919 and 1920.

TABLE I—ESTIMATED MONTHLY PRODUCTION OF BEEHIVE AND BYPRODUCT COKE AND OF PIG IRON IN THE UNITED STATES IN 1921

Month	Beehive Coke (Net Tons)	Byproduct Coke (Net Tons)	Pig Iron (Gross Tons)
Monthly average 1920	1,708,000	2,569,000	3,077,000
January, 1921	1,137,000	2,278,000	2,416,000
February	865,000	1,888,000	1,937,000
March	575,000	1,772,000	1,596,000
April	328,000	1,519,000	1,193,000
May	300,000	1,590,000	1,221,000
June	232,000	1,408,000	1,065,000
July	180,000	1,297,000	865,000
August	248,000	1,383,000	954,000
September	289,000	1,423,000	986,000
October	416,000	1,734,000	1,247,000
November	477,000	1,766,000	1,415,000
December	514,000	1,860,000	1,649,000
Total, 1921	5,561,000	19,918,000	16,544,000

TABLE II—SHOWS THE BYPRODUCT OVENS IN USE AT BEGINNING AND END OF 1921 AND UNDER CONSTRUCTION JAN. 1, 1922, BY TYPES

Type	In Existence Jan. 1, 1921	In Existence Jan. 1, 1922	Under Construction Jan. 1, 1922
Koppers	6,036	6,303	85
Semet-Solvay	2,415	2,463	..
United-Otto	1,513	1,413	..
Rothberg	282	282	..
Wilputte	206	206	..
Cambria-Belgian	250	310	..
Gas machinery	33	33	..
Klönne	42	42	..
Roberts	104	104	..
Piette	...	8	..
Total	10,881	11,164	85

Table I shows the production, by months, of each type of coke, and the output of pig iron.[1] The fluctuations in the output of coke evidently followed closely the fluctuations in the output of pig iron.

Capacity of Byproduct Ovens

The annual production of byproduct ovens in operation on Jan. 1, 1922, would be 44,275,000 net tons of coke if the ovens continued in operation without interruption 365 days in the year. As the average yield of coke for the industry amounts to 69.9 per cent of the coal used, this output represents a coal-carbonizing capacity of 63,340,000 net tons a year. However, operation at full capacity is impossible, even in periods of good demand for coke, and the figures for operation at 85 or 90 per cent of full capacity really represent a normal maximum for any considerable period. In other words, the byproduct coke ovens operable Jan. 1, 1922, can treat only about 55,000,000 net tons of coal a year.

[1]Figures on pig iron for 1920 from American Iron and Steel Institute; those for 1921 from *Iron Age*.

Legal Notes

By Wellington Gustin

Delivery f.o.b. Construed

In an action by the Partola Manufacturing Co. against the General Chemical Co., brought to recover damages for a breach of contract in the refusal to deliver blue vitriol, a judgment on trial was rendered favorable to the defendant, but this was reversed and a new trial granted. The sale in suit was made through a broker for the General Chemical Co., selling agent for Nichols Copper Co., to the Partola Mfg. Co., consisting of 150 tons Nichols Triangle brand 98-99 per cent, large crystals, blue vitriol, standard quality. A broker's memorandum was afterward amplified by written contracts. Goods were for consumption and not for resale. Plaintiff's factory was situated at 207 East Tenth St., and the delivery demanded by it upon Nov. 10, 1917, was for delivery at that place, or, if that were not practical, to any downtown New York pier. The brokers were the selling agents for the defendant, which had its factory in Long Island City, which is within Greater New York City.

The first question presented was the effect of a provision in the contract that delivery was to be in barrels "carload lots f.o.b. New York." Since the seller's works were at Long Island City, within Greater New York, and as the goods were sold for consumption by the plaintiff, whose factory was in Manhattan, this provision for delivery f.o.b. New York is ambiguous.

Some of the experts as to custom testified that the effect of this provision in such a contract has no significance. However, the court says an f.o.b. contract is recognized as placing the cost of transportation upon the buyer, and, while Long Island City is in Greater New York, a fair interpretation of this contract calls for a transportation of the goods to Manhattan at cost of the buyer.

The contract of sale required the buyer to give shipping instructions as to carrier and transportation, and as to whether the goods should be transported by truck or by water. Plaintiff failed to ask for deliveries in October and when it demanded deliveries on Nov. 10, the defendant replied that as October had passed it was not obliged to make deliveries upon the November demand. However, in view of the ambiguity of delivery, the court said delivery either to plaintiff buyer's factory or to some dock in New York City was not sufficiently specific.

Failure to Order Delivery of Installments

On the question of failure to order delivery of one or more installments under a contract providing for delivery by installment, section 126 of the personal property laws provides: "It depends in each case on the terms of the contract and the circumstances of the case whether the breach of contract is so material as to justify the injured party in refusing to proceed further and suing for damages for breach of the entire contract, or whether the breach is severable, giving rise to a claim for compensation, but not a right to treat the whole contract as broken."

The court said, assuming that there was unreasonable delay in sending shipping instructions and making demand for the installments which might be due in October, there is nothing in the case to show that such a failure on the part of the plaintiff was sufficiently material to authorize the defendant to renounce entirely its obligations under the contract. The court points out that it was only when the price of the product had risen somewhat and the execution of the contract would have been unprofitable to the defendant that it refused to perform, and then placed its refusal upon an entirely inadequate ground. In the written contract it is provided: "Each month's shipment to be treated as a separate and independent contract, but if buyer fails to fulfill terms of order, purchase or payment under this or other contracts, seller may defer further shipments until such default is made good, and may at its option treat such default as final refusal to accept further shipments hereunder." Refusal was not based on any such provision, so judgment was reversed and new trial granted.

No Recovery for Damage to Soda Lakes by Government Project

Suits involving Little Soda Lake and Big Soda Lake, located in Churchill County, Nevada, have been decided by the United States Supreme Court favorably to the federal government. Actions to recover $35,000 and $170,000 by the John Horstmann Co. and the Natron Soda Co., respectively, against the United States were begun in the Court of Claims. From judgments dismissing the actions the claimants appealed to the Supreme Court, which has affirmed the judgments.

Little Soda Lake and surrounding land were owned by the Horstmann Co., while Big Soda Lake was owned by the Natron Soda Co. and each was manufacturing soda from the waters of the respective lakes in 1906. This controversy turns upon the condition of the lakes at that time and their condition after an irrigation project was instituted by the government, called the Truckee Carson project.

The lakes are situated in an area known as the Carson Sink Valley, and in 1906 were dry bodies and the source of soda supply to the soda companies involved.

Level of Lakes Rise, Companies' Property Destroyed

From prior to 1867 to 1906 the level of the lakes had not varied more than 2 ft. In 1906 the United States Reclamation Service, acting under the authority of acts of Congress, constructed the Truckee Carson project, consisting of dams, canals and other structures whereby through the usual means large quantities of surface waters theretofore confined to the watershed of the Truckee River were in 1906 and thereafter each year transported to the watershed of the Carson River and distributed to various lands in the Carson River Valley, such that the volume of the water in the lakes has continually increased, and the level of the lakes has risen about 19 vertical feet up to 1916, in consequence of which the value of the companies' properties has been destroyed.

The government contended there was the absence of any causal connection between its works and the injury to the properties of the soda companies. The companies fought the governmental contention and deductions, and opposed to them the difference in conditions before and after the execution of the canal project, and their reasoning seems to have the support of the methods that the world employs in the investigation of its phenomena and instances, says the court. However, assuming that

there was causal connection between the work of the government and the rise of waters in the lakes and the consequent destruction of the soda properties, the court held that it did not follow that the government was under obligation to pay therefor, as for the taking of the properties.

APPROPRIATION OF PROPERTY IMPLIES CONTRACT TO PAY

It was contended that the appropriation of property by the government implies a contract to pay its value; and it was further declared that there need not be a physical taking, an absolute conversion of the property to the use of the public, but that if by public works the value of the property of an individual is substantially destroyed its value is taken within the scope of the Fifth Amendment.

The court says while this is a general rule, still there are exceptions. To bind the government there must be implication of contract to pay, but the circumstances may rebut that implication. That is, what is done may be in the exercise of a right and the consequences only incidental, incurring no liability.

THIS CASE OUTSIDE THE GENERAL RULE

It further announced that it would border on the extreme to say that the government intended a taking by that which no human knowledge could even predict. It was found that there is obscurity in the movement of percolating waters, and that there was no evidence to remove it in the present case, and necessarily there could not have been foresight of their destination nor purpose on the government's part to appropriate the properties. Any other conclusion would deter from useful enterprises on account of a dread of incurring unforeseen and immeasurable liability. This comment is of especial pertinence.

Mississippi Anti-Gin Act Upheld by Supreme Court

In a suit testing the constitutionality of an act of the Legislature of Mississippi called the "anti-gin act" the Supreme Court of the United States has upheld that law and affirmed judgment against the Crescent Cotton Oil Co. This act prohibits corporations from owning or operating any cotton gin, when such corporation is interested in the manufacture of cottonseed oil or cottonseed meal. A proviso permits cottonseed oil companies to operate gins of a prescribed capacity, but only in the city or town where their oil plants are located. A penalty is provided for violation of the act, but corporations are permitted to operate their gins for a reasonable time until they may be sold.

The Crescent company, organized under the Tennessee laws, owned and operated a cottonseed oil mill at Memphis, Tenn., and two cotton gins in Mississippi. It disregarded the anti-gin act, and the Supreme Court of Mississippi affirmed a judgment against it, declaring its right to do intrastate or local business in Mississippi forfeited, and perpetually enjoining it from operating cotton gins in the state, as well as ordering it to dispose of its gins operated within the state within 90 days. A penalty was also imposed.

The case was argued before the U. S. Supreme Court upon the assumption that the anti-gin act was enacted in aid of the anti-trust laws of the state, under the conviction on the part of the Legislature that it was the practice of corporations operating oil mills and cotton gins to depress the price of ginning regardless of cost, until local competition was suppressed or brought to terms, and then to charge excessive prices for ginning and to pay unfairly low prices for seed.

COMPANY CLAIMED UNCONSTITUTIONALITY

The company relied upon the unconstitutionality of the act, which it asserted upon two grounds—namely, first, that as to the company it imposes a direct and substantial, and therefore unconstitutional, burden upon an instrumentality of interstate commerce, and second, that the act, being applicable to corporations and not to individuals owning and operating cotton gins, it denies to the company the equal protection of the laws.

The basis of the first contention was the claim that it had become impracticable for the oil company to carry on its oil-manufacturing business successfully when purchasing its cotton seed supply from other ginners or from brokers, that for this reason the company acquired its two cotton gins in Mississippi and nine in other states to obtain the advantages of purchasing seed direct from the growers of cotton, and that all the cotton seed which it had purchased in connection with gins was shipped in interstate commerce to its oil mill at Memphis, the gins being in effect "feeders" to its oil mill, and therefore essential means and instrumentality of interstate commerce.

MANUFACTURE IS NOT COMMERCE

But the Supreme Court says manufacture is not commerce, and though an article, when in the process of manufacture, is intended for export to another state, this circumstance does not render it an article of interstate commerce.

It is only when the ginning of cotton is completed, and the seed, if sold for shipment out of the state, has been committed to a carrier for interstate transport, that it passes from the regulatory power of the state into interstate commerce and under the federal laws and power.

Again, it is said that since manufacturing operations are not commerce, cotton gins are not instrumentalities of interstate commerce; and the anti-gin act, prohibiting the ownership or operation of any cotton gin by any corporation interested in the manufacture of cottonseed oil or meal, does not impose a direct burden on interstate commerce in violation of the United States Constitution, though the corporation operating again ships all the cotton seed purchased in connection with its gins in interstate commerce. Further, the court says, the act does not deny the equal protection of the laws to foreign corporations owning cotton gins in Mississippi, because applying only to corporations, since, where a foreign corporation has no federal right to do business in a state, and no contract right is involved, and there is no employment by the federal government, the state may impose conditions in its discretion on the right of such corporation to do business, even to the extent of excluding it altogether, and in such case the inherent difference between corporations and natural persons sustains restrictions applicable to corporations alone.

Again, any reasonable classification, not arbitrary, adopted by a state in the exercise of police power will be sustained against an attack based upon the equal protection clause of the Fourteenth Amendment, and the anti-gin act, forbidding operation of cotton gins by corporations manufacturing oil or meal, does not make a classification so without reasonable basis as to be arbitrary, because applying only to corporations.

The Manufacture of Electrolytic Iron

General Data for a Commercial Plant Manufacturing Pure Iron for Electrical Purposes—Effect of Composition, Temperature and Circulation of the Electrolyte Upon the Physical Properties of the Deposited Metal

By G. F. McMahon

ELECTROLYTIC IRON deposited from the ammonium sulphate-chloride-ferrous sulphate bath after treatment by special processes is suitable as a substitute for certain grades of sheet iron and iron wire in various types of electrical equipment. Up to within the last few years its use on a commercial scale made slow progress, its high cost delaying investigation and manufacture perhaps more than anything else.

There is a process in Grenoble,[1] France, now in commercial use manufacturing boiler tubes from a ferrous chloride electrolyte. The Eustis process,[2] a chloride process, promises to become commercial in this country. It is the purpose of these to produce a more or less ductile deposit by exercising special control of the electrolyte temperature and current densities used. It is the purpose of the process to be described to produce a brittle deposit, also by special means, that can be pulverized. The first two processes referred to in this paragraph differ from the third in purpose as well as in technical detail.

Electrolytic iron was first made in about 1860 by Bietz[3] for the purpose of making a few magnetic tests. Shortly after that more tests were made by numerous other scientists. Boettger[4] probably was the first man to make any commercial use of the material. He deposited iron from a ferrous ammonium sulphate solution for the purpose of facing printer's type.

C. F. Burgess and Taylor[5] tested electrolytic iron for its magnetic properties after being deposited and cut into rings. They found the material hard and brittle. Dr. Burgess and Carl Hambeuchen[6] produced about 1,000 lb., for experimental purposes only, about the year 1904 by using an aqueous solution of ammonium sulphate and ferrous sulphate as the electrolyte. Previous to these investigations Stotelow[7] in 1873 tested electrolytic iron for its magnetic properties after being deposited. He used a ring of soft electrolytic iron with two coils wound around it and obtained important results on the permeability of such material.

A very good bibliography on these earlier investigations is compiled by T. Yensen,[8] who has done noteworthy work on melting and alloying in vacuo, together with subsequent testing of the metals.

If a chemical analysis were made of the electrolyte used by O. P. Watts and M. H. Li[9] in 1914 in their experiments on the "Effect of Addition Agents in Electrodepositing Iron," it would be found to be nearly the same as that used in the operation of a large plant, although different chemicals are used to start. Ammonium chloride may be used in place of ferrous chloride to obtain the desired chlorine content. Whatever the electrolyte lacks in ammonia may be made up by adding the correct proportion of ammonium sulphate; the iron content is obtained by using the correct amount of ferrous sulphate (copperas). Ammonium chloride is more desirable to use than ferrous chloride, which is sometimes hard to obtain in large quantities.

Ammonium chloride had been used previous to 1886 and is mentioned by Alexander Watt in his book on Electrodeposition published in that year. He mentions that Gore had used that material successfully together with ferrous sulphate. I have found this to hold true in the operation of small baths, but in large volumes the ammonium concentration must be increased.

General Layout

In design, an electrolytic iron refining unit can be laid out on the same general principles as a copper, zinc or lead refinery—that is, the tanks are connected electrically in series-parallel and are approximately of the same size. Wooden tanks, inside dimensions of 3 ft. wide, 10 ft. long and 4 ft. deep, are built and assembled together on piers well above the basement floor. No lining is necessary.

The electrolyte is generally neutral or very slightly acid or alkaline in reaction. Lead piping gives the best service and withstands corrosion better than wrought iron, cast iron or bronze, although any of the latter may be used for some time before showing appreciable signs of wear.

The writer has found it necessary to filter the electrolyte continuously in order to keep the impurities at a minimum. Electrolyte flows through each tank at the rate of approximately 3 gal. per minute. The overflow is collected in a launder and carried to a pump tank, where it is mixed with Filter-Cel and pumped by a special type bronze centrifugal pump through a clam-shell Sweatland filter press.

It is advisable to have more than one filter press in operation to permit cleaning of the filter leaves periodically without delaying filtration. The use of diatomaceous earths promotes the formation of a porous cake on the filter leaves. Experimentally it has been found almost impossible to filter any great length of time unless such material is used, on account of the slimy nature of the solids which tend to fill up the pores of the filter cloth.

From the filter press the clear electrolyte flows to the head tank, whence it flows by gravity into the electrolytic tanks and again to the pump tank, the flow

[1] "Electrolytic Iron a Commercial Product," by Bradley Stoughton, CHEM. & MET. ENG., Jan. 18, 1922, vol. 26, p. 128.

[2] C. P. Perin and D. Belcher, *Mining and Metallurgy*, December, 1921.

[3] Bietz, *Phil. Mag.*, vol. 20, p. 458 (1860).

[4] "Electrodeposition," by Alexander Watt, 1886.

[5] Burgess and Taylor, *Trans.* Am. Inst. Electrical Engineers, vol. 25, p. 459 (1906).

[6] Burgess and Hambeuchen, *Trans.*, Am. Electrochem. Soc., vol. 5 (1904).

[7] Stotelow, *Phil. Mag.*, vol. 45, p. 40 (1873).

[8] Yensen, Bull. Univ. of Illinois, vol. 11, No. 28. Vol. 12, No. 29. Vol. 13, No. 12.

[9] Watts and Li, *Trans.*, Am. Electrochemical Soc., vol. 25 (1914).

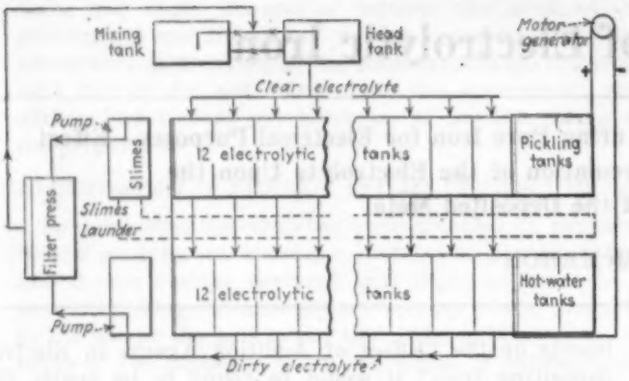


FIG. 1—SCHEMATIC LAYOUT OF ELECTROLYTIC IRON PLANT. CAPACITY 40 TONS PER MONTH

being a complete cycle. Provision is also made for the collection of anode slimes during clean-up periods and for their filtration. A traveling crane should be used, with capacity of 4 tons, for lifting sixteen electrodes at one time from a tank. Current is supplied by a 120-kw. d.c. generator, 3,300 amperes at approximately 36 volts. Pickling and hot water tanks are also installed, with the necessary steam and water lines. Fig. 1 illustrates the layout of tanks.

ANODES

Where a good grade of electrolytic iron is to be manufactured, the anode must be as pure as possible. For ordinary purposes bessemer or open-hearth steels can be used. Anodes generally used have the following approximate chemical analysis:

	Per Cent		Per Cent
Carbon	0.60	Manganese	0.30-0.50
Phosphorus	0.05	Sulphur	0.10
Silicon	0.23		

Anodes are cast to size, 3 ft. 8 in. x 3 ft. 5 in. x 2 in. thick, overall dimensions. The main body of the anode is 2 ft. 4 in. x 3 ft. 3 in. x 2 in. thick. The lugs are approximately 1 in. in thickness.

Sixteen anodes are generally used per tank on a spacing of approximately 7½ in. center to center. More anodes and cathodes can be used on closer spacing, but the current efficiency and quality of deposit are adversely affected.

CATHODES

The cathode starting sheets are made from cold-rolled steel ⅛ in. thick x 2 ft. 6 in. x 3 ft. 8 in., riveted to solid hard-drawn copper bars, ½ in. x 1 in. x 41 in. long. In order to prevent the deposited iron from falling off the sheet steel blanks, which sometimes occurs, I found it advisable to drill several ¾-in. holes in the plate about 6 in. apart near the solution line. During deposition the metal nearly fills up these holes and binds the deposit to the blank sheet.

Fifteen cathodes are used per tank. The sheet steel cathode blanks before being used for deposition of the iron are pickled in dilute sulphuric acid, washed in hot water and coated with a light grade of mineral oil, preferably kerosene. Cathodes receive a 12- to 13-day deposit of iron and at the end of that time are removed, washed well in hot water and dried in an air blast. The iron deposit is then stripped, and is nearly ¼ in. thick. It has the following approximate chemical analysis:

	Per Cent		Per Cent
Carbon	0.014	Manganese	0.029
Phosphorus	0.013	Sulphur	0.003
Silicon	0.028		

It is an interesting fact that small tanks, containing 5 gal. or less, do not easily permit the formation of "trees" on the cathodes. The fact that treeing took place at an unprecedented rate during the early operation of a large unit caused the author a great deal of worry. After making slight changes in the electrolyte this undesirable condition was almost eliminated. It was found that the addition of only a trace of glue to the electrolyte rounded off the edges and sharp points, reducing the amount of treeing.

ELECTROLYTE

The electrolyte used is composed of ammonium and ferrous salts dissolved in water. It has the following approximate chemical analysis:

Iron	60 grams per liter
Chlorine	25 grams per liter
Ammonia	25 grams per liter

The successful deposition of iron depends almost entirely upon the care used in maintaining this electrolyte.

While at first perhaps slightly acid in reaction, the electrolyte later becomes alkaline, and additions of sulphuric or hydrochloric acids in calculated amounts become necessary. Otherwise the deposit becomes full of suspended dark green ferrous hydrate. An electrolyte slightly acid in reaction produces a brittle, curly and mirror-like plate, although other conditions to be discussed later sometimes produce a similar result. If the electrolyte is neutral or very slightly alkaline, an excellent matte gray deposit is obtained which is not quite so brittle and is more adherent. The latter is the plate desired.

When cold the electrolyte is a poor conductor of electric current. It is advisable to warm the solution to about 45 deg. C. before turning on the current. An open steam jet is used. After the electrolyte becomes warm no further external heating is necessary. During summer months the temperature will rise somewhat above 45 deg. C. and unless good ventilation is resorted to the heat and humidity are oppressive to the workmen.

There is practically no loss, other than carrying-out losses, of ammonia, chlorine or iron during electrolysis. The iron, on the contrary, increases in concentration due to the addition of acids. Acid consumption is not high and does not add much to the cost of operation.

POWER

A current density of between 12 and 15 amp. per sq.ft. of immersed cathode area produces satisfactory results. The actual yield of deposited iron at the above current density is approximately 90 per cent of the theoretical amount calculated according to Faraday's law; 3,300 amp. is used per tank at approximately 1.3 volts. The average output per kilowatt hour is approximately 1.5 lb. of refined iron.

EXPERIMENTAL DATA

Unless otherwise stated, all experimental results noted in Table I were obtained at a current density of approximately 12 amp. per sq.ft. of immersed cathode area with the electrolyte at approximately room temperature, 25 to 30 deg. C.

The chemical analyses of the electrolytes are expressed in grams of Fe, NH_3 and Cl per 100 c.c. The capacity of the bath used was a little less than 10 gal.

Glue. A small amount is distinctly beneficial in the operation of large tanks, a fact which the early investigators, Watts and Li,[3] overlooked, or rather did not

perhaps have the opportunity to investigate. When other conditions are as they should be, glue forms deep solid ridges lengthwise of the cathode, which are very desirable when a solid plate, free from trees, is desired.

Stratification and Re-solution. Formation of different solution layers is caused by inefficient circulation of the electrolyte, a common occurrence in the electrolytic refining of several metals. Slow circulation is very apt to permit the acid additions to settle to the bottom of the tanks, while the top liquors become strongly alkaline in reaction. This of course affects the appearance of the cathode deposit, and an experienced operator can readily detect the condition by inspection.

Cathode re-solution is dependent on the purity of the deposited iron and on the ammonium concentration.

Ammonia. Low ammonia in the electrolyte causes the cathode to gas badly during deposition, due probably to re-solution of the iron from the resulting acid reaction, or from the decomposition of water, or both. If the ammonia concentration is not increased, the current efficiency is lowered and a rapid increase in the iron concentration of the electrolyte occurs, if acid additions are made in order to keep up the appearance of the deposit.

In large tanks the ammonium concentration of the electrolyte is therefore of great importance. Low ammonia also seems to reduce the magnetic permeability of the resulting iron, probably due to the greater amount of hydrogen in the immediate vicinity of the cathode. In small tanks no such wide variation occurs, on account of better electrolyte circulation.

TABLE I—SUMMARY OF TEST CATHODES

Grams Per 100 c.c. Fe	NH_3	Cl	Glue	Elec. Temp.	Remarks
6.00	1.30	2.50	None	Room	Good plate.
6.00	1.30	2.50	Trace	Room	Good plate.
6.00	1.30	2.50	Excess	Room	Bad plate, brittle.
6.00	1.30	2.50	Excess	Room	Bad, brittle, laminated.
6.00	1.60	0.10	None	Room	Rough plate.
6.00	1.60	0.80	None	Room	Fair plate.
6.00	1.60	1.50	None	Room	Fair plate.
6.00	1.60	2.79	None	Room	Smooth plate.
6.00	1.25	2.48	None	52 deg. C.	Good plate, soft.
6.00	1.25	2.48	None	23 deg. C.	Good plate, hard, brittle.
6.00	0.00	1.60	None	Room	Spongy.
6.00	0.40	1.60	None	Room	Slightly spongy.
6.00	0.75	1.60	None	Room	Good plate.
6.00	2.02	1.60	None	Room	Good, peeled at start.
8.00	1.60	2.75	None	Room	Rough.
3.50	1.34	2.50	None	Room	Good plate.

A high ammonia concentration improves the conductivity and increases the current efficiency, but it sometimes produces a shiny, brittle deposit similar to that from a slightly acid electrolyte. I am of the opinion that some slight impurity in the ammonium sulphate (the commercial grades do vary greatly from gas and coke-oven plants) is producing this effect, as this condition soon wears itself out and finally a good deposit is obtained. With no ammonia in the electrolyte, a soft mushy deposit of no apparent commercial value was obtained.

Sulphate. Another feature affecting the appearance of the iron deposit is a high ferrous sulphate concentration. This condition will increase the tendency of the cathode to "tree."

Chlorine. A high chlorine concentration is generally beneficial. If there is occluded chlorine or chlorides in the metal, rapid corrosion will occur on exposure to the atmosphere. Care must be exercised therefore in the control of the chlorine content of the electrolyte and in the cathode deposit.

Temperature and Hardness. The temperature of the electrolyte affects several things, the most important being the hardness and magnetic permeability of the metallic deposit. It must not be understood, however, that all variations in permeability are due to lack of temperature control. Some other causes have already been mentioned.

Iron deposited at a temperature over 50 deg C. from this electrolyte is softer than that deposited at 25 deg. C., other conditions being the same. The hydrogen content, which is quite difficult to determine, as well as the crystalline structure, may be affected by temperature of deposition. Hardness tests made on a Brinell machine, using 500 kg. pressure and a 10-mm. diameter ball, were not satisfactory, since the material was too brittle and cracked under the strain. Scleroscope hardness was 35 to over 40. A satisfactory method of determining the difference in hardness is by noting the time taken to pulverize a definite amount to a sized powder, say 80 mesh. Highly permeable soft material oftentimes takes several days to pulverize, while harder material may be easily reduced in a few hours.

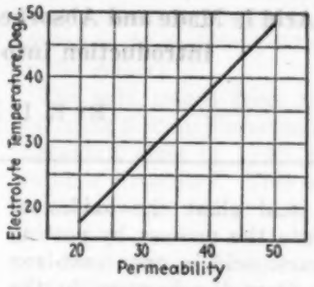


FIG. 2—EFFECT OF TEMPERATURE OF DEPOSITION ON PERMEABILITY. H = 1

Temperature and Permeability. If electrolytic iron be deposited at different temperatures under the same conditions with respect to current density and composition of the electrolyte, its magnetic permeability is almost directly proportional to the temperature of the electrolyte between the limits 25 and 50 deg. C. See Fig. 2.

The variation in the permeability of freshly prepared electrolytic iron has been known for some time and has been discussed by Terry.[10] Apparently he did not investigate the causes for such variation from the standpoint of electrodeposition, which is of importance. It has been the writer's experience that the rate of annealing and the permeability obtained is dependent largely upon the electrolytic baths and the changes occurring therein.[11]

Cement-Making Prospects in Ceylon

Some time ago several samples of clay and lime were sent from Ceylon to the Imperial Institute in London to ascertain if any of them were suitable for the manufacture of cement. It is now reported that some Jaffna clays are quite suitable for the purpose.

The commercial aspect of the manufacture of cement in Jaffna (an island separated by a very narrow channel from the northern extremity of Ceylon) is now being examined. The main difficulty, so the Ceylon correspondent of the *London Times Trade Supplement* reports, is the high price of coal. The possibility of developing a small hydro-electric scheme to operate the plant is now being studied. Experiments are also being made to find out if palmira or coconut shells could be used in place of coal.

The clays and limes of the island have not been studied systematically with a view to employing them for industrial purposes.

[10] Terry, *Phys. Rev.*, vol. 30, p. 133 (1910).
[11] Storey, *Trans.*, Am. Electrochemical Soc., vol. 25 (1914).

Introduction of Niter Into Sulphuric Acid Processes as Mixed Acid

A Description of a Successfully Operating Auxiliary Plant in Which Nitric Acid Is Made and Absorbed in Glover Tower Acid for Introduction Into the Main System

BY E. L. LARISON

IN THE usual sulphuric acid plant the oxides of nitrogen are introduced into the process by potting nitrate of soda and sulphuric acid in open cast-iron pots set in the flue leading from the burners to the Glover tower.

A few plants make nitric acid in a separate apparatus and run it into the Glover tower as required. In some cases fuel-fired retorts are used, the vapors of which discharge into the gas stream entering the Glover tower. Introduction of water solution of nitrate of soda into towers or chambers is practiced to a certain extent also.

A somewhat different plan has been in use at Anaconda for the past 4 years, and it has worked out so smoothly and presents such economies that a description of it seems worth while. This scheme has also been used at Garfield and perhaps two or three other places. When the plant was installed at Anaconda it was believed to be a new departure, but since that time it has developed that one of the explosives companies tried out substantially the same arrangement for making mixed acid about 15 years ago. The scheme was not suitable, however, for the purposes of the company.

In brief, this plant consists of one or more standard nitric acid retorts, a condensing tower, a coil pipe acid cooler, a pump and the necessary tanks. Nitrate of soda and 60 deg. Bé. sulphuric acid are introduced into the retorts and heated by a coal fire to produce nitric acid vapor. This vapor is conducted into the base of a small masonry tower, over which is continuously circulated a definite charge of cool 60 deg. Bé. sulphuric acid. The nitric acid is condensed and the warm mixture of sulphuric and nitric acids issuing from the tower is passed through the cooler, pumped up and reintroduced into the tower. When the nitrate of soda has been completely decomposed, a mixed acid of definite composition has been made. This mixed acid is introduced as needed into the Glover towers of the chamber and packed cell plants.

ADVANTAGES OF THIS METHOD OVER USUAL PRACTICE

This arrangement presents several advantages over any of the others enumerated above. In the ordinary potting plant the vicinity of the pots is usually a mess, difficult to keep tidy and shipshape. There are, too, certain things wrong in theory about potting. The introduction of the charges is usually accompanied by an inrush of air which dilutes the gas. The evolution of the nitric acid is irregular, a fresh charge giving it off rapidly then slowing down to almost nothing. In starting up or in case of irregular running, just when it is desired to get in an abnormal amount of niter, the flue is cold and one must wait, sometimes a day or two, to establish a process, or else tap out incompletely decomposed charges. Potting must be done at rather frequent intervals. Except in very small plants, at least one man must be on duty all the time to charge and tap.

In the mixed acid scheme under discussion a clean little independent plant does the work. The nitric acid is introduced into the chamber process at an absolutely uniform rate which can be perfectly controlled. No false air is admitted. Starting up the chambers is accomplished in a few hours and irregularities in the flow of SO_2 are easily kept pace with. One man in one shift can make mixed acid corresponding to 4,000 to 5,000 lb. of niter.

The chief advantage over fuel-fired pots discharging into the flue is in the lower labor requirements. The advantages over the straight nitric acid plant lie in the simplicity and rugged character of the mixed acid plant and in the fact that this mixed acid can be handled in ordinary lead and iron pipes, pumps and tanks, just about as 60 deg. Bé. sulphuric acid can be handled.

An installation which has been in use for the past 4 years and which has given entire satisfaction is shown in plan and elevation in Figs. 1 and 2.

RETORT DETAILS AND SETTING

The retorts, Fig. 3, are of the usual design and are 6 ft. inside diameter and 6 ft. inside depth. They were cast at the local foundry and the metal mixture used was steel scrap 35 per cent, No. 1 pig 32.5 per cent, No. 2 pig 32.5 per cent. These retorts have a very long life, certainly more than 1,500 charges.

The construction of the brick setting is perhaps a little different from that ordinarily used. The tapping

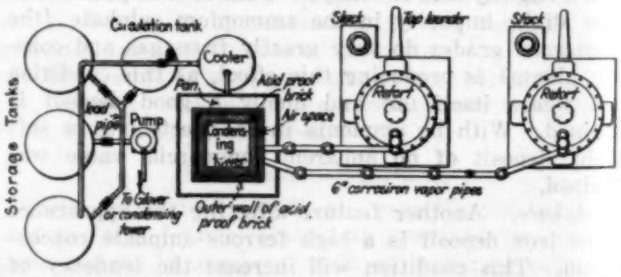


FIG. 1—PLAN OF MIXED ACID PLANT. SITE, 50x25 FEET

spout is on the opposite side from the fire and ash doors, an arrangement which is more convenient than having them on the same side. The fire gases are directed around the pots by corbeling in the walls as shown in Fig. 4. A solid 9-in. arch of firebrick covers the firebox, and the spout is protected from direct action of the flame by a small brick pier. The retort cover con-

tains the usual openings for charging and carrying away vapor, and is covered with brick.

The connections between the retorts and the condensing tower are of 6-in. Corrosiron pipe with horizontal bell joints. These pipes are apparently unaffected by 4 years service.

The Condensing Tower

The condensing tower serving these two retorts is of acid-proof brick laid in silica-silicate of soda mortar. The walls consist of 9-in. main wall with a 4-in. veneer

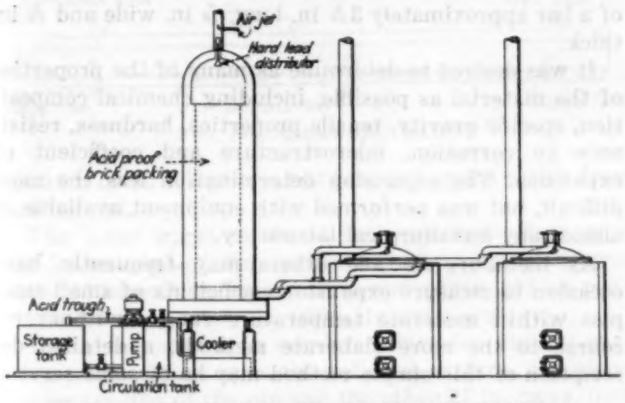


FIG. 2—ELEVATION OF MIXED ACID PLANT

course separated 2 in. from the main wall, but bonded to it in places. This construction makes the outside of the tower entirely clean and dry, as any acid which leaks through the main wall cannot cross the 2-in. space between the walls. The top of the tower is a hemispherical brick dome.

This tower is 20 ft. high and 4 x 4 ft. inside. The packing is of standard dimension acid-proof brick laid on edge and the column is 12 ft. high. The gross packed volume is therefore 192 cu.ft. The tower is built in a

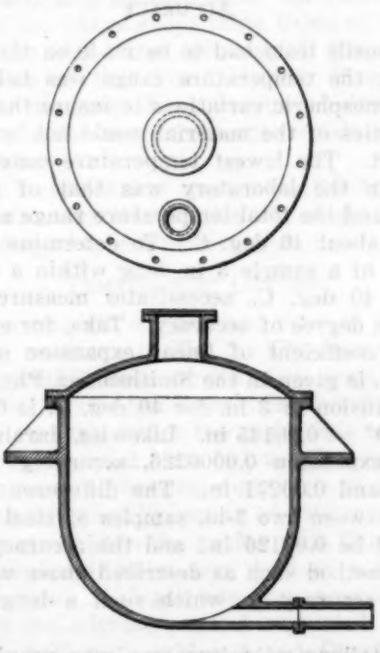


FIG. 3—TYPE OF NITRIC ACID RETORT USED

pan of 24 lb. lead with the upper part of the pan sides of Corrosiron plates. The sides of the pan are about 12 in. from the walls of the tower. This pan was originally of lead throughout, but it was found that the side walls from the acid level to the top were quickly corroded away. The lead was therefore cut down to a line a few inches below the acid level and Corrosiron plates were put in. This corrected the trouble. Beyond this no changes or repairs whatever have been necessary on this tower and it will probably require none for many years to come.

Acid is fed into the tower and distributed through a hard lead splash plate. A 6-in. Corrosiron pipe containing an air jet leads from the top of the tower to a point just above the roof. The air to this jet is so controlled as to maintain 0.25 to 0.50 in. of water suction at the retorts.

The acid issues from the tower pan into a circular lead tank 5 ft. in diameter and 3 ft. deep, containing two concentric coils of 1½-in. lead pipe through which cold water is circulated. This cooler is covered, and in operation is always full of acid. It discharges into either a circulation tank or a storage tank as desired. The tanks are connected to the boot of a cast-iron Lewis vertical centrifugal pump, which pumps to the top of the condensing tower or to the top of the Glover tower of the chamber plant. The performance of this pump has

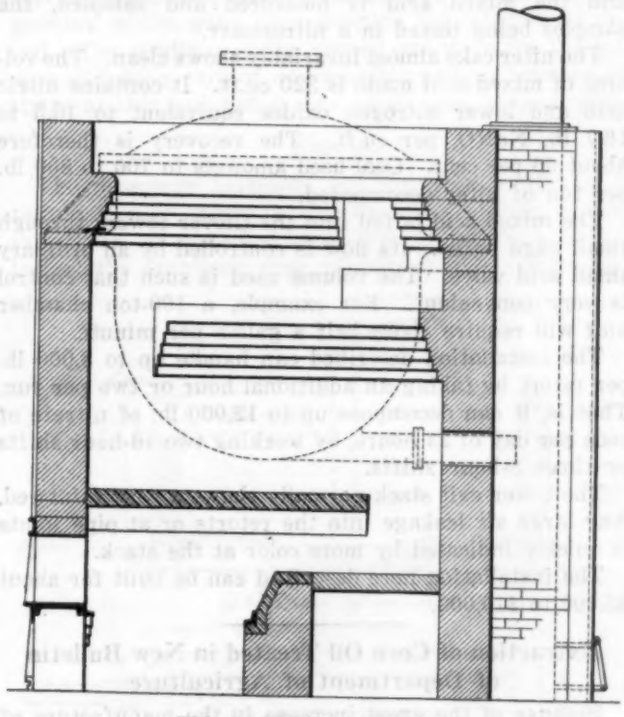


FIG. 4—RETORT SETTING

been rather remarkable. It has operated about 8 hours almost every day for over 2 years and not a cent has been expended upon it in the way of repairs.

Operation of Plant

Ordinarily the operation of this plant is conducted with the following routine. The operator comes on at 7:30 a.m. and with the help of one laborer puts 2,000 lb. of nitrate of soda into each retort, with 2,500 lb. of 60 deg. Bé. sulphuric acid. This occupies 30 to 40 minutes. The laborer is then released and the remainder of the run is conducted by one man alone.

Fire is started under the retorts and a charge of 60 deg. Bé. sulphuric acid for the condensing tower is drawn. For 4,000 lb. of nitrate of soda this acid charge amounts to 165 cu.ft., or about 8.8 tons. This acid is put into circulation over the tower, through the cooler and circulating tank and back to the pump. Once this

circulation is properly set it requires no further attention. The rate of acid flow is about 3 to 4 tons per hour.

Hourly temperatures are taken at the vapor exit of each retort and of the acid entering and leaving the condensing tower. The firing is conducted largely with these as a guide. A typical set of these temperatures is given in the following table.

TABLE I

Time	Temperature of Retort, Deg. F.	Temperature of Acid Entering Tower, Deg. F.	Temperature of Acid Leaving Tower, Deg. F.
8:00 a. m.	...	70	70
9:00 a. m.	230	70	78
10:00 a. m.	248	78	110
11:00 a. m.	256	85	122
12:00 m.	278	95	134
1:00 p. m.	290	95	150
2:00 p. m.	290	85	142
3:00 p. m.	240	82	118
3:15 p. m.	Retort tapped		

After tapping the retort the mixed acid is run to one of the storage tanks or to the tank at the top of the Glover tower. The niter cake is sampled as it runs out and the mixed acid is measured and sampled, the samples being tested in a nitrometer.

The niter cake almost invariably shows clean. The volume of mixed acid made is 220 cu.ft. It contains nitric acid and lower nitrogen oxides equivalent to 16.5 to 16.7 lb. $NaNO_3$ per cu.ft. The recovery is therefore about 96 per cent. Coal used amounts to 700 to 800 lb. per ton of niter decomposed.

The mixed acid is fed into the Glover towers through small gage boxes. Its flow is controlled by an ordinary small acid valve. The volume used is such that control is very convenient. For example, a 100-ton chamber unit will require about half a gallon per minute.

The installation described can handle up to 3,000 lb. per retort by taking an additional hour or two per run. That is, it can decompose up to 12,000 lb. of nitrate of soda per day of 24 hours, by working two 10-hour shifts or three 8-hour shifts.

The tower exit stack normally shows a very faint red. Any large air leakage into the retorts or at pipe joints is quickly indicated by more color at the stack.

The installation here described can be built for about $8,000 to $10,000.

Extraction of Corn Oil Treated in New Bulletin of Department of Agriculture

Because of the great increase in the manufacture of corn products, such as hominy, starch, glucose and sirup, the production of oil from the germ, which is removed in these various processes, has become a well-established industry. Up to the present the oil has been removed from the germs by pressure, a method that is used in this country in obtaining most kinds of vegetable oils. In European countries a good deal of vegetable oil extraction has been done with organic solvents, and recently the United States Department of Agriculture has made some trials with this method of extracting corn oil. The results have just been published in Department Bulletin 1,054, "Comparison of Corn Oils Obtained by Expeller and Benzol Extraction Methods," a professional paper by A. F. Sievers, chemical biologist.

The bulletin contains detailed comparisons of processes and of oils produced by pressure and by solvent extraction from the germ cake, a residue from the first process, and by solvent extraction from the germs themselves.

Determining Coefficient of Expansion With a Metallurgical Microscope

By Horace C. Knerr
Metallurgist, Naval Aircraft Factory, Philadelphia

THE METHOD of measuring thermal expansion herein described was developed in the course of an investigation of the physical properties of a small piece of a light alloy at the Naval Aircraft Factory. The sample, which was all that was available, was in the form of a bar approximately 3⅞ in. long, ⅞ in. wide and ⅛ in. thick.

It was desired to determine as many of the properties of the material as possible, including chemical composition, specific gravity, tensile properties, hardness, resistance to corrosion, microstructure and coefficient of expansion. The expansion determination was the most difficult, but was performed with equipment available in almost any metallurgical laboratory.

As metallurgists and others may frequently have occasion to measure expansion coefficients of small samples within moderate temperature ranges without recourse to the more elaborate methods, a detailed description of this simple method may be of some service.

Method of Measurement

The determination was made with the aid of an inverted metallurgical microscope, by measuring the difference in expansion between the sample and pieces of steel and of duralumin, placed on each side, the temperature being regulated by a water bath. Observations were taken through glass windows in the bottom of the bath. Preliminary readings were taken at intervals, until a number of consecutive readings were identical, showing that the temperature of the specimen had become constant.

Accuracy

Since tensile tests had to be made on the same piece afterward, the temperature range was held to within normal atmospheric variations to insure that the physical properties of the material would not by any chance be affected. The lowest temperature conveniently obtainable in the laboratory was that of melting ice, 0 deg. C., and the total temperature range available was therefore about 40 deg. C. To determine the thermal expansion of a sample 3 in. long within a temperature range of 40 deg. C. necessitates measurements of a fairly high degree of accuracy. Take, for example, soft steel. A coefficient of linear expansion of 0.0000121 per deg. C. is given in the Smithsonian Physical Tables. Total expansion in 3 in. for 40 deg. C. is $0.0000121 \times 3 \text{ in.} \times 40° = 0.00145$ in. Likewise, duralumin (coefficient of expansion 0.0000226, according to Vickers) would expand 0.00271 in. The difference in total expansion between two 3-in. samples of steel and duralumin would be 0.00126 in., and the accuracy of the result of a method such as described above would depend upon the accuracy to which such a length could be measured.

The metallurgical microscope was provided with a micrometer eyepiece which was calibrated by means of a micrometer stage ruled to 0.1 and 0.01 mm. One division on the graduated head, using a 16-mm. objective, represented 0.0000330 in., or about 2½ per cent of the probable length (0.00126 in.) to be measured. It was possible to repeat readings to within plus or minus one

scale division. This, therefore, came well within the desired accuracy of plus or minus 5 per cent.

Preparation of the Specimen

A strip of annealed mild steel and a strip of duralumin were attached to opposite sides of the specimen, as shown in Fig. 1, the three pieces being pinned together at one end by a tight fitting pin and left free at the other end. Small spring clips were placed at the free end and at the middle, permitting longitudinal expansion or contraction of all the pieces, but preventing the strips from bowing out.

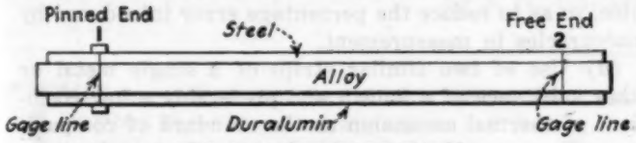


FIG. 1—ASSEMBLED BARS

The lower edges of the strips were made flush with the lower edge of the specimen, and this surface was polished smooth by emery cloth and paper laid on plate glass, finishing with No. 0000 Hubert paper.

Using the jaws of a vernier caliper for guides, gage lines were scribed upon the polished surface, one above the center line of the pin and the other 2½ in. away, both running transversely across the three strips. It was necessary to draw very fine lines, a feat which is perhaps the most difficult part of the entire experiment. A piece of microscope cover glass was shattered and a small sharp splinter selected with the aid of a magnifying glass. This was attached by means of a speck of beeswax to the end of a fairly stiff bristle about 2 in. long taken from a dust brush. This "scriber" was drawn across the polished surface of the three strips as gently as possible, using the vernier jaws as guides. These gage lines were barely visible to the naked eye, but were clear and definite under the microscope, and appeared in the image about three times as wide as the hairline of the micrometer eyepiece. It was easy to read to the center of this line. Heavier "marker lines" scribed near the gage lines facilitated determinations of direction under the microscope, which is otherwise very confusing.

The lines were ruled at room temperature, 24 deg. C. After ruling, a very thin coating of transparent varnish was applied so as to retard corrosion.

Temperature Control

A small watertight wooden box, open at the top, was constructed, as shown in Fig. 2. This was arranged to fit on the movable stage of the microscope. Holes cut in the bottom of this box were covered with microscope cover glass through which the gage lines on the specimen could be observed from below. To avoid cracking the cover glasses by unequal expansion, they were separated from the wood by means of rubber washers, the glass being attached to the rubber with Canada balsam.

For convenience, water was used as a heating and cooling medium. A 5-gal. can was placed on a high shelf above the microscope, and connected to the inlet tube of the bath with rubber hose. Overflow drained to a bucket on the floor. Flow was adjusted with a pinch-cock so as to cause a complete displacement of the liquid in the bath every 30 seconds. This insured excellent circulation about the specimen and permitted a continuous flow for about 1 hour and 20 minutes, which was ample time for the specimen to reach the temperature of the bath and for readings to be taken. The water in the 5-gal. reservoir was permitted to come to room temperature for the first set of readings, at approximately 24 deg. C. For the second readings, cracked ice was placed in the reservoir to cool the water to 0 deg. C., and for the third readings a small electric heater was arranged to warm the water to 40 deg. C. To insure uniform temperature in the reservoir, a motor-driven agitator was used.

The specimen was placed in the bath with the gage lines over the windows; it was raised slightly upon narrow strips of glass to permit circulation of water beneath it. With the water circulating, the temperature of the bath was measured with a thermometer at various places and was found uniform within about 0.2 deg. C.

Using the metallurgical microscope and micrometer eyepiece, readings were taken through the window at the pinned end of the relative positions of the gage line on the strip at both sides of the sample. The microscope stage, carrying the bath, was then moved so as to bring the other end of the specimen in position over the objective, and a reading taken of the relative position of the gage lines through the window at that end. The readings at the pinned end were for the purpose of taking care of any possible motion between the strips at this end, but it was found that none occurred.

Results

The necessary formulas and the results of the determination are given further below. Satisfactory readings were not obtained at 40 deg. C., as the water attacked the specimen very rapidly at this temperature in spite of the varnish, so that the gage lines were obliterated. The results obtained between 0 and 24 deg. C. showed the coefficient of expansion to be approximately that of magnesium. Other characteristics of the sample, determined later, disclosed that it was composed largely of magnesium.

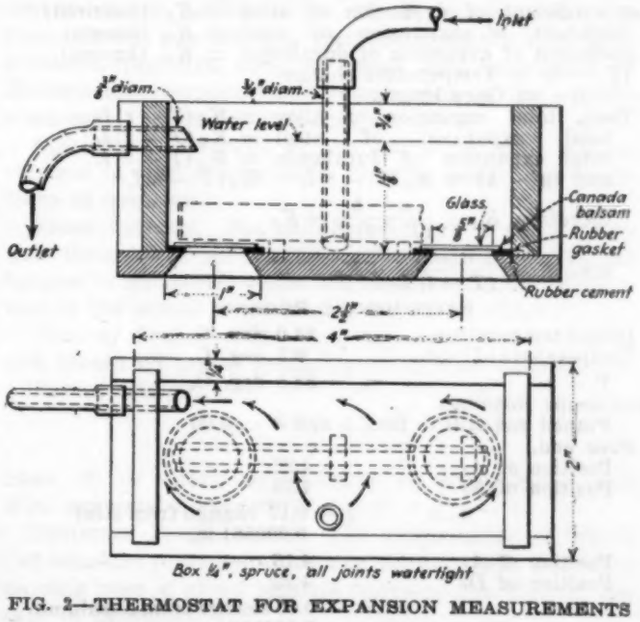


FIG. 2—THERMOSTAT FOR EXPANSION MEASUREMENTS

It will be noted that there was a considerable difference in the result determined by comparison with the steel strip and that determined by comparison with the duralumin strip. This inconsistency may be largely due to inaccuracy of the coefficients given for those metals

in the best available sources. There was no check upon the coefficient 0.0000226 given for duralumin from the Vickers' Bulletin, and the value 0.0000121 for steel was practically an average or approximation from several widely differing values given for steels and irons in the texts. In order to obtain accurate results by this method, it is essential to have for comparison a standard piece whose temperature coefficient is known to a

FIGS. 3 AND 4

Fig. 3 (at left)—Pinned end at normal temperature.
Fig. 4 (at right)—Free end at higher temperature.

greater accuracy than that required in the test. This is true of most methods of measurement—in fact, practically all measurements of length depend upon comparison with a previously measured standard.

As the standards of this experiment were not known to be correct, the results are of value chiefly for the sake of example.

Formulas

See Figs. 3 and 4

A movement of A_2 from S_2, to the right is plus a.
A movement of A_1 from S_1, to the right is plus b.
A movement of A_2 from D_2, to the right is plus c.
A movement of A_1 from D_1, to the right is plus d.
Difference in total expansion of alloy and steel $= a - b$.
Difference in total expansion of alloy and duralumin $= c - d$.

Let coefficient of expansion of alloy $= K_A$ (required)
coefficient of expansion of steel $= K_S$ (known)
coefficient of expansion of duralumin $= K_D$ (known)
$(T - t)$ = Temperature change
L = Gage length.
Then, total expansion of alloy $= K_A(T - t)L$
total expansion of steel $= K_S(T - t)L$
total expansion of duralumin $= K_D(T - t)L$
and $(a - b) = K_A(T - t)L - K_S(T - t)L$

$$\text{therefore, } K_A = \frac{a - b}{(T - t)L} + K_S$$

$$\text{also, } K_A = \frac{c - d}{(T - t)L} + K_D$$

Experimental Readings

Initial temperature 24.0 deg. C.
Temperature of bath 0.5 deg. C.
$T - t$ $= -$ 23.5 deg. C.

Microscope Readings
Pinned end still in line, b and $d = 0.00$
Free end,
Position of A_2 4.22
Position of S_2 4.39
$a = -$ 0.17 change from steel
$= -$ 0.000561 in.
Position of A_1 4.16
Position of D_1 4.22
$c = -$ 0.06 change from duralumin
$= -$ 0.000198 in.

$$K_A = \frac{0.000561}{23.5 \times 2.50} + 0.0000121 = 0.0000216 \text{ per deg. C.}$$

(compared with steel).

$$K_A = \frac{0.000198}{23.5 \times 2.50} + 0.0000226 = 0.0000260 \text{ per deg. C.}$$

(compared with duralumin).

Average 0.0000238 per deg. C.

This first test was hastily prepared and rather crudely performed, and the writer has not had an opportunity to repeat it with greater care. It is believed that the method has demonstrated its practicability, and improvements in detail can easily be introduced.

Some improvements which suggest themselves are:

(*a*) Use of a ruling machine or construction of a jig to facilitate the scribing of the fine gage lines. Tremors of the hand in the present method tended to cause irregular gage lines.

(*b*) Use of a light transparent oil as a heating and cooling medium, to avoid corrosion of the specimen (where this is likely to occur with water) and permit greater temperature ranges.

(*c*) Using greater ranges of temperature when possible, so as to reduce the percentage error introduced by inaccuracies in measurement.

(*d*) Use of two similar strips of a single metal or other substance of a known and preferably a low coefficient of thermal expansion as the standard of comparison. These would serve as a check against each other, and in case of warping or bending of the sample, the mean of the readings on the two sides would give the correct value. Invar would be an excellent material for this purpose.

Advantages of the Method

(*a*) The equipment is available in nearly any metallurgical laboratory.

(*b*) Results do not depend upon the accurate measurement of small changes in a relatively large quantity, but upon measuring a small *difference* between two quantities, one of which is known. A fairly accurate measurement of this small difference gives a relatively high percentage accuracy in the result.

(*c*) The determination may be made upon a small sample, the preparation of which is simple and requires no accurate machine work or grinding.

(*d*) Determinations may be made within ordinary atmospheric ranges or within any range which can be obtained with a fairly transparent liquid bath.

(*e*) The standard of comparison is subject to the same conditions of temperature, etc., as the specimen.

(*f*) The unit of length measurement (micrometer eyepiece) is entirely out of range and unaffected by variations of temperature in the heating medium.

(*g*) Displacements in various parts of the measuring apparatus do not affect the accuracy of the results.

(*h*) The length of the specimen between gage marks does not need to be measured with great accuracy. A good vernier caliper is suitable.

(*i*) The measurements are optical, avoiding the inaccuracies due to touch or to uncertain contacts, characteristic of micrometer or electric contact methods.

Japanese Experiment on Bread From Soya Bean Flour

Japanese food chemists are at work to produce a palatable bread from soya bean flour, and according to a report in the *Bulletin of the Japan Society*, tests thus far indicate that it is both palatable and digestible. It is also established that soya bean bread can be placed on the market at a price below that made from any other kind of flour. With the heavy protein content of the beans and a little butter or other fat, a ripe orange and a dish of boiled greens, it would seem that a very cheap ration—with vitamines included—was available from it. The soya bean cheese should also furnish an abundance of protein.

It is, of course, a question as to how the bread will take with the public. If it does find favor, however, it will worry the wheat grower.

Contributions to the Study of Ammonia Catalysts—IV

Discussion of the Behavior of a Type of Iron Catalyst Under Varying Conditions of Pressure, Temperature and Gas Velocity in Experiments on the Synthesis of Ammonia at the Fixed Nitrogen Research Laboratory*

By A. T. LARSON and R. S. TOUR

THE preceding articles of this series have described three types of apparatus for testing the activity of substances in catalyzing the synthesis of ammonia from nitrogen and hydrogen. The particular functions of each of these testing plants have been indicated in the separate articles. The purpose of the present article is to present data obtained by all of these methods of testing, on certain selected catalysts which have come to be regarded as typical, and to show to what extent correlation exists between the results of low, intermediate and high pressure testing, and between small and moderate scale operation.

It should be pointed out that the most important function of each of the three testing plants has been the determination of the comparative merits of a large number of catalysts rather than a logical study of the complicated phenomena involved in ammonia synthesis. Each plant has had a more or less distinct place in the general research program and has followed lines of investigation frequently differing from that adopted by the others. There are certain difficulties inherent in the problem which render almost impossible a complete identity of conditions in tests carried out upon different scales. Thus the reaction evolves a considerable amount of heat, and the heat evolution and distribution in a given volume of catalyst may vary greatly with the rate of flow of the gases and with the temperature and pressure, since these affect the reaction rate as well as the equilibrium concentration of ammonia. This means that it is inevitable that a certain temperature gradient must exist within the catalyst and although this is kept at a minimum by devices previously indicated, it is impossible to be certain that the recorded temperatures of the different testing plants operating under widely different conditions actually correspond to identical temperature conditions within the catalyst.

Again, although the catalysts are always tested upon a 1:3 nitrogen:hydrogen mixture of a high degree of purity, except when poisons are intentionally introduced, the methods employed for gas purification have not been identical and it is therefore impossible to be certain that the quality of the gas is always the same. There is reason to believe, however, that the variation in purity has been small enough to be of but minor importance and further, although the catalysts are fairly reproducible, still minor variations in activity or characteristics may appear in different batches of what is presumably the same catalyst.

It is therefore not to be expected that absolute concordance of results should have been achieved in studying substances so sensitive to conditions as contact catalysts are apt to be, nor that all results should be strictly comparable. Nevertheless, sufficient data have been obtained to warrant the statement of certain important generalizations concerning the behavior of characteristic ammonia catalysts under varying conditions of pressure, temperature, rate of flow of gases, purity of gases and other factors.

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*For Parts I, II and III see CHEM. & MET. ENG., vol. 26, Nos. 11, 12 and 13, pp. 493, 555 and 588, March 15, 22 and 29, 1922.

NOMENCLATURE

Certain terms appearing in this paper are occasionally given a different meaning from that employed herein and it seems desirable, therefore, to define them.

Per Cent Ammonia. The per cent by volume of NH_3 in the gas, measured under standard conditions.

Ammonia Conversion. The *increase* in NH_3 per cent in the gas produced by catalysis.

Yield of Ammonia. The weight of ammonia produced by catalysis. When expressed in grams of NH_3 per liter of catalyst per hour, it becomes the *"space-time-yield"* ("S-T-Y").

Equilibrium or Theoretical. (Applied to per cent NH_3, conversion or yield.) This refers to the maximum theoretically possible for specified conditions of temperature, pressure, etc., assuming the correctness of Haber's measurements and calculations of the equilibrium constant for the ammonia synthesis.

Efficiency. The ratio of the actual per cent NH_3 in the gas to that theoretically possible under the conditions in question.

Space Velocity. The number of liters of gas passing over the catalyst per liter of catalyst per hour. The gas volume is measured under standard conditions regardless of the actual conditions of operation ("S.V.").

Time of Contact. The time in seconds for 1 liter of gas, measured under operating conditions, to pass over 1 liter of catalyst.

$$\text{"t.c."} = \frac{3600}{S.V.} \times \frac{P \times 273}{T}$$

Here, P = operating pressure in atmospheres and T = absolute temperature, deg. C.

Optimum Temperature. The temperature at which (at constant pressure and space velocity) the gas after passing over a given catalyst contains the highest per cent of ammonia.

NATURE OF THE CATALYST

The catalysts of the type selected for discussion consist essentially of metallic iron containing small amounts of a substance which influences very greatly the behavior of the iron and which is known as a "promoter." The amount of promoter in the particular catalysts used for illustration, which will be referred to as Nos. A, B, C and D, is from 2.5 to 3.5 per cent of the total weight, the remainder being metallic iron. These catalysts have been selected as a basis for discussion for various reasons. They are reasonably active, capable of

continued operation without marked deterioration, and sufficiently sensitive to poisons and overheating to permit their use in discussing these problems. Although they are not the most active catalysts which have been prepared by the Fixed Nitrogen Research Laboratory, they are nevertheless high-grade catalysts, more active than those which have usually been employed in commercial operation.

While the experimental data presented will be from the actual tests of these particular catalysts, certain generalizations will be made based upon more extensive results obtained with similar catalysts.

Preparation of Catalysts and Methods of Testing

These catalysts are first prepared as mixed oxides and are then heated in a current of nitrogen:hydrogen mixture, which reduces the iron oxide to metallic iron. The samples of catalysts employed for the small-scale apparatus, both for low- and high-pressure operation, are reduced at atmospheric pressure by placing them, usually in the form of 8 to 14 mesh granules, in a furnace and slowly heating them in a current of pure nitrogen:hydrogen mixture until reduction begins, as evidenced by the appearance of water in the outlet gas. The temperature is maintained at this point until the evolution of water ceases (usually several hours) and is then raised somewhat until water reappears. This process of heating at gradually increasing temperature is continued until practically complete reduction is effected, the final temperature being 400 to 450 deg. C.

In the moderate-scale testing plant the catalysts are prepared by reducing the oxide granules (6 to 8 mesh) *in situ* in the catalyst bomb by means of nitrogen:hydrogen mixture at 100 atmospheres pressure, with gradually increasing temperature.

After reduction the sample of catalyst is usually tested under varying conditions of temperature and space velocity, and with pure and poisoned gas.

Influence of Mesh Size of Catalyst

Since the size of the catalyst granules in the three testing plants varies from 8 to 14 mesh at the lower pressures to 6 to 8 mesh at high pressure, it is important to determine the effect of mesh size upon the catalytic activity. Tests carried out at 100 atmospheres and confirmed by data obtained at lower pressures indicate that the activity of the catalyst is independent of the size of granule, within fairly wide limits. These data are given in Table I.

TABLE I—INFLUENCE OF MESH SIZE OF CATALYST.

Catalyst	Pressure, Atm.	Temp., Deg. C.	Space Velocity	4 to 8 Mesh Eff.	8 to 10 Mesh Eff.	12 to 14 Mesh Eff.
C	100	475	5,000	0.950	0.980	0.940
C	100	475	10,000	0.878	0.891	0.880
C	100	475	20,000	0.683	0.717	0.727
C	100	475	40,000	0.514	0.547	0.550
D	100	475	5,000	0.904	0.900	0.897
D	100	475	10,000	0.742	0.730	0.700
D	100	475	20,000	0.567	0.590	0.540
D	100	475	40,000	0.408	0.460	0.380

The individual differences are scarcely greater than the limits of reproducibility of the catalysts. Furthermore, experiments have been carried out on the influence of the shape of the catalyst chamber and no evidence has been found of such influence. Apparently the yield of NH_3 is dependent only upon the amount of catalyst, other conditions being constant, and not upon the size of particle or shape of the container. These facts make possible the direct comparison of the results obtained at the different testing plants, in so far as these effects are concerned.

Influence of Previous History on Catalytic Activity

Chemical composition alone does not, of course, determine catalytic activity. Catalysts of identical composition but different previous history may exhibit widely differing behavior. Whereas the catalysts selected for discussion in this article have in general been subjected to similar treatment, occasional variations, intentional or otherwise, in the routine may have produced certain differences which are especially apparent at low temperatures, where catalytic activity is just beginning. Nevertheless sufficient data are available to enable the drawing of definite conclusions in most cases.

With proper attention to composition of materials and experimental technique, the catalysts selected as typical can be reproduced within reasonable limits. Their characteristics, therefore, may be taken as representing a certain class of catalysts rather than as individual preparations.

Basis of Comparison

In comparing the behavior of catalysts under different conditions of temperature and pressure it is a little difficult to decide upon a satisfactory basis of comparison. From a commercial standpoint either the per cent of NH_3 produced or the yield of NH_3 per hour is most important. On the other hand, in considering the actual activity of the catalyst it must be remembered that the per cent of NH_3 can never exceed that existing at equilibrium and this changes with both pressure and temperature. Comparisons of catalytic activity based upon per cent of NH_3 are therefore apt to be misleading unless conditions of pressure and temperature are identical. Therefore for the purpose of an analysis of catalytic activity under varying conditions of temperature and pressure it seems more logical to select the efficiency (as defined above) as a basis of comparison, although it must be kept in mind that the efficiency may also be a function of the variable conditions and a true comparison of catalytic activity of different catalysts is possible only when conditions are identical. In order to aid in an understanding of the factors which play a part in determining the suitability of a catalyst for commercial ammonia synthesis, the data have been also analyzed upon a basis of the per cent of NH_3 formed and the yield of NH_3.

The efficiency, the per cent of NH_3 and the yield of NH_3 are influenced by four separate variables—pressure, temperature, rate of flow of gases, and concentration of catalyst poisons. The methods used in analyzing the data is in general to plot the efficiency or the per cent of NH_3 as ordinate and one variable factor as abscissa, holding two factors constant. A family of curves is then drawn, each curve corresponding to a different value of one of the constant factors. It would, of course, be possible to construct many additional families of curves from the available data, but it is believed that those selected for illustration serve to indicate sufficiently the general nature of the principles involved.

It is understood, of course, that many other factors besides pressure, temperature, rate of flow and concentration of poison may impose necessary restrictions on the actual conditions of commercial operation. Among these factors are heat losses, ammonia removal, gas

purification, mechanical construction, etc., and no attempt is made to include them in the discussion. It should be emphasized, however, that the determination of the most favorable conditions for commercial operation is a problem of considerable complexity and cannot be intelligently decided upon without a careful consideration of such factors as are discussed in this paper.

Since the "equilibrium values" are referred to frequently, it seems worth while to include for reference a table of these values calculated from the data of Haber by means of the nomograph recently devised by Tour.[1]

TABLE II—EQUILIBRIUM PER CENT OF NH_3, BY VOLUME

Temp., Deg. C.	Pressure, Atmospheres 1	10	31.6	100
400	0.457	4.25	11.45	25.4
420	0.347	3.27	9.10	21.5
450	0.236	2.24	6.45	16.45
475	0.170	1.66	4.93	13.00
500	0.128	1.26	3.77	10.40
550	0.076	0.755	2.32	6.66

Experimental Data

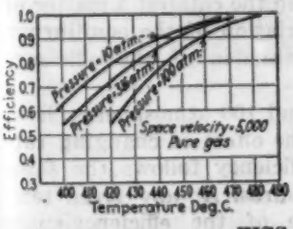
The experimental data which have been selected for analysis in this paper are given in condensed form in Table III. In some cases they represent the average of a considerable number of determinations, in others only a single observation. In any case they represent the best data available at the present time and although further experiment may result in some changes, it is not believed that such changes will necessitate any material alterations in the general conclusions drawn herein.

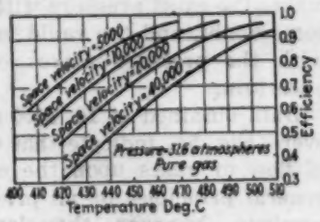
The Efficiency of Ammonia Formation

The Effect of Temperature at Different Pressures

Every catalyst, in general, requires a certain time at the beginning of a test, and to a lesser extent in changing from one temperature to another, before reaching a steady condition as to ammonia production. This time is naturally greatest at the lower temperatures, when many hours may be required, and much less at high temperatures. The steady condition may be maintained indefinitely if pure gas is being tested. Unless otherwise stated, all results given in this paper will be those obtained after the steady condition has been reached.

Catalytic activity for the type of catalyst in question begins at 400 deg. C. or less and increases with increasing temperature until the condition of equilibrium is approximated (for space velocities around 5,000) at 450 to 475 deg. C. and above, if pure gas is tested. At low





FIGS. 1 AND 2

Fig. 1—Effect of temperature on conversion at different pressures.

Fig. 2—Effect of temperature on conversion at different space velocities.

temperature, and especially at low pressure, the results obtained are apparently so dependent upon the previous history of the particular sample of catalyst that reproducible results are difficult to obtain. Nevertheless, reasonably certain conclusions can be drawn as to rate of change of the efficiency with changing temperature at pressures from 1 to 100 atmospheres. In general, the efficiency always increases with increasing temperature, the rate of change being almost independent of the pressure (Fig. 1). Between efficiencies of 0.4 and 0.85 the increase in efficiency with increasing temperature is nearly linear and the slope is not materially different at different pressures. At efficiencies of about 0.90 the rate of increase with increasing temperature diminishes somewhat, and the efficiency-temperature curves approach the value 1.0 rather slowly. The nature of the curves for low efficiencies is uncertain, owing to the irregularity of the results, but it is probable that a point of inflexion is shown and that the efficiency of zero is also approached slowly at low temperatures.

TABLE III—DATA ON TEST RUNS

Catalyst	Temp., Deg. C.	Pressure, Atmospheres	Space Velocity (× 1,000)	Per Cent NH_3 by Vol.	Efficiency	Composition of Gas
A	400	1.0	5	0.300	0.680	Pure
A	450	1.0	5	0.220	0.930	Pure
A	500	1.0	5	0.130	1.000	Pure
A	550	1.0	5	0.078	1.000	Pure
A	400	10.0	5	2.68	0.630	Pure
A	420	10.0	5	2.65	0.795	Pure
A	450	10.0	5	2.10	0.930	Pure
A	500	10.0	5	1.25	1.000	Pure
A	400	31.6	5	6.01	0.525	Pure
A	410	31.6	5	6.59	0.640	Pure
A	420	31.6	5	6.65	0.725	Pure
A	430	31.6	5	6.50	0.795	Pure
A	440	31.6	5	6.23	0.855	Pure
A	450	31.6	5	5.85 (6.00)	0.900 (0.920)	Pure
A	500	31.6	5	3.72	0.990	Pure
A	550	31.6	5	2.30	0.990	Pure
A	425	100.0	5	12.90	0.610	Pure
A	450	100.0	5	14.10	0.850	Pure
A	475	100.0	5	12.80	0.980	Pure
A	420	10.0	10	2.19	0.665	Pure
A	420	10.0	20	1.71	0.750	Pure
A	420	10.0	40	1.35	0.405	Pure
A	450	10.0	10	1.95	0.850	Pure
A	450	10.0	20	1.71	0.750	Pure
A	450	10.0	40	1.50	0.668	Pure
A	420	31.6	10	5.46	0.595	Pure
A	420	31.6	20	4.24	0.465	Pure
A	420	31.6	40	3.71	0.317	Pure
A	450	31.6	10	5.41	0.832	Pure
A	450	31.6	20	4.66	0.717	Pure
A	450	31.6	40	3.71	0.570	Pure
A	500	31.6	10	3.65	0.960	Pure
A	500	31.6	20	3.61	0.950	Pure
A	500	31.6	40	3.43	0.900	Pure
A	450	100.0	10	11.60	0.705	Pure
A	450	100.0	20	9.50	0.578	Pure
A	450	100.0	40	7.00	0.427	Pure
A	450	31.6	5	2.36	0.365	0.04 per cent H_2O
A	450	31.6	10	1.26	0.195	0.04 per cent H_2O
A	450	31.6	20	0.83	0.125	0.04 per cent H_2O
A	450	31.6	40	0.49	0.077	0.04 per cent H_2O
A	500	31.6	5	3.43	0.900	0.04 per cent H_2O
A	500	31.6	10	2.60	0.685	0.04 per cent H_2O
A	500	31.6	20	2.00	0.525	0.04 per cent H_2O
A	500	31.6	40	1.22	0.320	0.04 per cent H_2O
A	450	31.6	5	1.04	0.160	0.10 per cent H_2O
A	450	31.6	10	0.60	0.092	0.10 per cent H_2O
A	450	31.6	20	0.50	0.078	0.10 per cent H_2O
A	450	31.6	40	0.38	0.060	0.10 per cent H_2O
A	500	31.6	5	2.75	0.720	0.10 per cent H_2O
A	500	31.6	10	1.63	0.430	0.10 per cent H_2O
A	500	31.6	20	1.16	0.305	0.10 per cent H_2O
A	500	31.6	40	0.78	0.180	0.10 per cent H_2O
B	450	100.0	5	14.30	0.870	Pure
B	450	100.0	5	5.10	0.310	0.044 per cent CO
B	450	100.0	5	2.30	0.140	0.082 per cent H_2O
B	500	100.0	5	10.40	1.000	Pure
B	500	100.0	5	8.84	0.850	0.044 per cent CO
B	500	100.0	5	5.72	0.550	0.082 per cent H_2O

Effect of Temperature at Different Space Velocities

Curves illustrating the effect of temperature upon the efficiency at constant pressure but different space velocities are shown in Fig. 2. From these it appears that between space velocities of 5,000 and 40,000 the general nature of the curves is the same, the effect of an in-

[1] *J. Ind. Eng. Chem.*, vol. 13, p. 298 (1921).

crease in space velocity being largely to displace the curves along the temperature axis.

Effect of Temperature With Poisoned Gas

In Fig. 3, data are plotted illustrating the temperature coefficient of the efficiency at constant pressure and and space velocity, with pure gas and with gas poisoned with carbon monoxide and water vapor. The data are not altogether conclusive, but they indicate that the effect of poison is largely to displace the curves along the temperature axis.

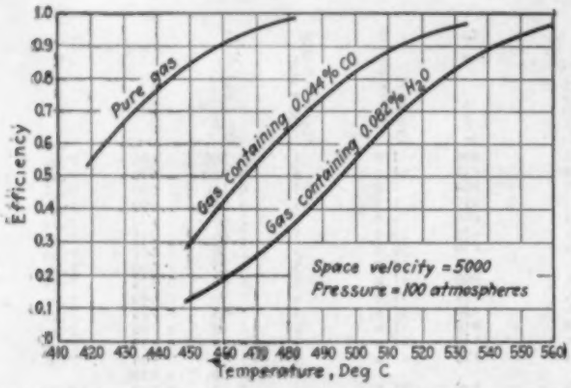
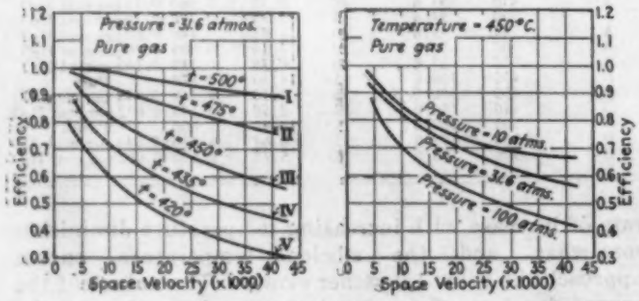


FIG. 3—EFFECT OF TEMPERATURE ON CONVERSION WITH POISONED GAS

Although the data are not sufficiently concordant or complete to permit a mathematical formulation, it is apparently true that the curves expressing the change of efficiency with temperature are always of the same type, showing a point of inflexion and slowly approaching the efficiency unity at high temperatures and zero at low temperatures. The effect of a change in pressure or space velocity or the introduction of poison is largely that of displacing the efficiency-temperature curves along the temperature axis.

Effect of Rate of Flow on Efficiency at Different Temperatures

The effect of the rate of flow of gas upon the efficiency can be predicted to a certain extent from *a priori* consideration. Thus at zero space velocity the efficiency

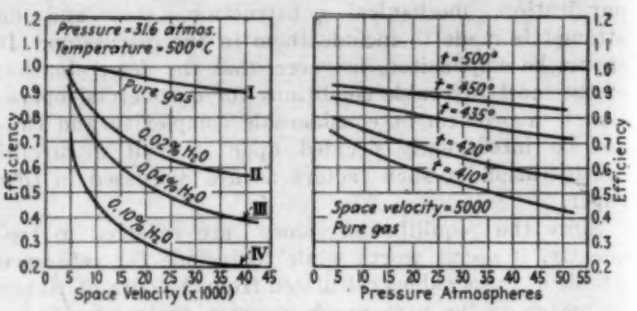


FIGS. 4 AND 5

Fig. 4—Effect of rate of flow of gases on conversion at different temperatures.

Fig. 5—Effect of rate of flow of gases on conversion at different pressures.

must be unity under any conditions and (excluding the possibility of complications arising from lack of turbulent flow at extremely low space velocities) as the space velocity becomes finite, the efficiency will in general remain approximately unity for a range of space velocities which will be greater the higher the temperature, the more active the catalyst and the purer



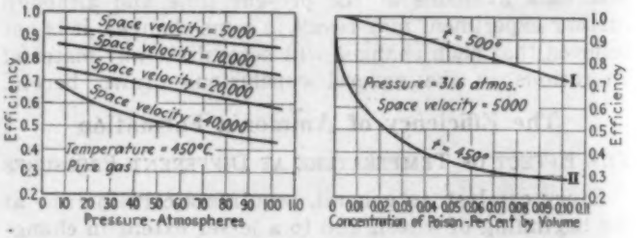
FIGS. 6 AND 7

Fig. 6—Effect of rate of flow of gases on conversion with poisoned gas.

Fig. 7—Effect of pressure on conversion at different temperatures.

the gas. Also, at very high space velocities the efficiency may be expected to approach zero asymptotically. Between these two extremes the nature of the efficiency-space velocity curves cannot be predicted, except that a point of inflexion must occur somewhere.

These considerations are in general borne out by the result of experiment. Thus data obtained at constant pressure (31.6 atm.) and different temperatures are expressed graphically in Fig. 4. It will be observed that at 500 deg. C. the efficiency is practically unity at space velocities up to 10,000, while at 420 deg. the efficiency



FIGS. 8 AND 9

Fig. 8—Effect of pressure on conversion at different rates of flow.

Fig. 9—Effect of poisons on conversion at different temperatures.

is far below unity even at 5,000 space velocity and begins to decrease much less rapidly at a space velocity of 40,000.

Effect of Rate of Flow at Different Pressures

Very little data are available on the effect of space velocity on the efficiency at atmospheric pressure, due to the fact that the increase of frictional resistance of the catalyst mass and the apparatus at high space velocities makes the exact pressure within the catalyst a matter of some doubt, and the rapid variation of the equilibrium with the pressure makes estimates of the efficiency uncertain.

Data obtained at 10, 31.6 and 100 atmospheres, however (Fig. 5), indicate that the effect of changing rate of flow of gases upon the efficiency follows the same general principles at all pressures. At any given temperature, however, the slope of the efficiency-space velocity curves increases somewhat with increasing pressure.

Effect of Rate of Flow With Poisoned Gas

Relatively little data are available upon the effect of rate of flow of gases with gas containing poisons. Characteristic data are illustrated by the curves plotted in Fig. 6. It is apparent that the general nature of the efficiency-space velocity curves is the same for pure and

for poisoned gas, the effect of poison being similar to that of a reduction of temperature (compare Fig. 4, curves I and V, with Fig. 6, curves I and III).

The Effect of Pressure at Different Temperatures

A great deal of catalyst testing has been done at low pressures, especially atmospheric, because of the ease with which such tests can be carried out, and for this reason it is a matter of great practical importance to determine to what extent results obtained at one pressure may be used to predict results at other pressures.

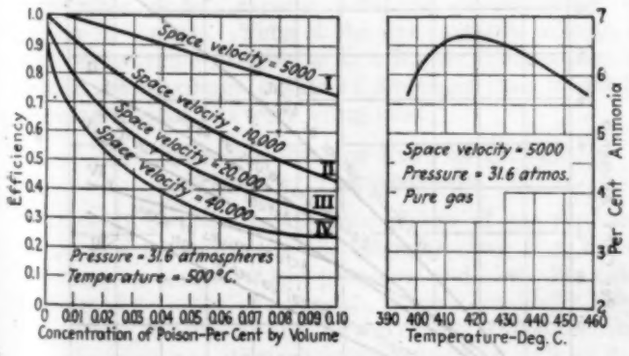
From the data plotted in Fig. 7 it appears that at constant temperature and space velocity the efficiency always decreases slowly with increasing pressure, the effect being greater the lower the temperature selected for test.

Effect of Pressure at Different Rates of Flow

Since, as indicated above, the decrease in efficiency with increasing rates of flow of gases is somewhat greater at high than at low pressures, it follows that the decrease in efficiency produced by increasing pressure must also increase with increasing space velocity. That is $\left(-\frac{dE}{dP}\right) S.V.$ increases with increasing space velocity within the range of space velocities for which data are available—up to 40,000. This is illustrated by the curves in Fig. 8.

Effect of Pressure With Gas Containing Poisons

The data on poisoned gas are somewhat irregular and inconclusive, their interpretation being made more difficult by the progressive permanent deterioration of the catalyst (discussed below) which may occur especially



FIGS. 10 AND 11

Fig. 10—Effect of poisons on conversion at different rates of flow.

Fig. 11—Effect of temperatures on ammonia content at constant space velocity and pressure.

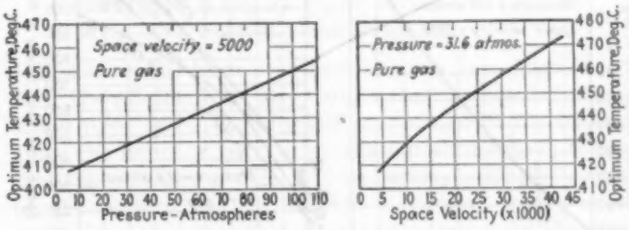
in long-continued tests. However, all of the available data point to the conclusion that the decrease in efficiency produced by increasing pressure is greater for poisoned gas than for pure gas.

In general it appears to be true that if the catalyst is operating under such conditions that the efficiency is close to unity — $\frac{dE}{dP}$ will be relatively small. For conditions under which the efficiency is somewhat lower, whether produced by low temperature, high space velocity or poisons, — $\frac{dE}{dP}$ will be greater. However, if the conditions are such that the efficiency is very low (approaching 0) the value of — $\frac{dE}{dP}$ will again become small.

All of these facts must be borne in mind in comparing results obtained at different pressures and in attempting to predict the behavior of a catalyst at one pressure from data obtained at other pressures. In particular, attention may also be called at this time to the fact that the decrease in efficiency with pressure has been found to be much greater for some catalysts than for those described in this paper. Hence tests which show a catalyst to be very active at 1 atmosphere pressure cannot in general be taken as indicating that the catalyst will be active under conditions suitable for commercial operation.

The Effect of Poisons at Different Temperatures

The only two catalyst poisons studied in any quantitative way are carbon monoxide and water vapor, these being the two impurities most difficult to remove from commercial nitrogen : hydrogen mixtures. Most of the



FIGS. 12 AND 13

Fig. 12—Effect of pressure on optimum temperature.

Fig. 13—Effect of space velocity on optimum temperature.

experimental data have been obtained with only one or two concentrations of poison and even these results are less reproducible than the data obtained when pure gas is used. The conclusions as to the variation of the efficiency with the concentration of poison are therefore more tentative than is the case with the data on pure gas. Nevertheless, certain generalizations seem reasonably certain.

In general, it may be noted that as far as the data are available, no difference can be detected between the effect of carbon monoxide and that of water vapor, if equivalent volume percentages of either gas are considered. This is perhaps to be expected, as at the temperatures in question carbon monoxide is readily converted into water vapor by the catalyst, according to the reaction

$$CO + 3H_2 = H_2O + CH_4$$

In the discussion, therefore, data obtained with either poison will be plotted upon the same curves and treated as though only one poison were being considered.

In general, either poison produces a lowering in the efficiency, this lowering always increasing with increasing concentration of poison. Comparing the results at different temperatures, it will be seen from the curves in Fig. 9 that the lowering in efficiency produced by any given concentration of poison is greatest at low temperatures and decreases with increasing temperature, so that at 500 to 550 deg. C. for low space velocities and low concentrations of poison the efficiency may be unity, as it is on pure gas.

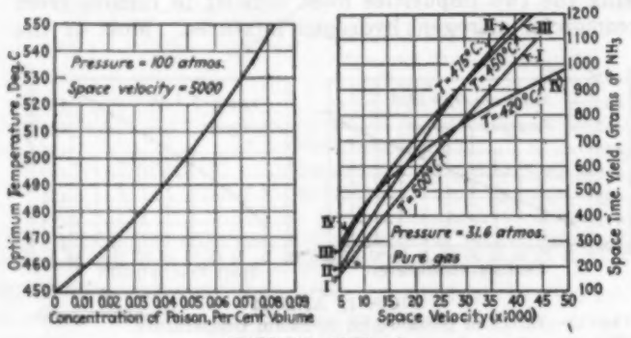
The rate of change in the efficiency with increasing concentration of poisons $\left(-\frac{dE}{dC}\right)$ is itself a function

of the temperature. Thus at high temperatures the efficiency decreases nearly linearly with increasing concentration of poison, while at low temperatures a large initial decrease in efficiency is followed by a much more gradual decrease (compare curves I and II, Fig. 9).

It should be noted that complete recovery of the catalyst occurs when again tested upon pure gas after treatment with poisoned gas, provided the time of treatment with poisoned gas was short. After more extensive tests on poisoned gas and especially at high pressures, permanent injury to the catalyst results. This is discussed further below.

The Effect of Poisons at Different Rates of Flow of Gases

The decrease in efficiency produced by a given concentration of poison in the gas alters greatly with the rate of flow of gases. A comparison of the curves in Fig. 10 with those in Fig. 9 shows that the effect of an increase in the space velocity is very much the same


Pressure = 100 atms.
Space velocity = 5000
Optimum Temperature, Deg. C.
Concentration of Poison, Per Cent Volume
Pressure = 31.6 atms.
Pure gas
Space Velocity (x1000)
Space Time Yield, Grams of NH3

FIGS. 14 AND 15

Fig. 14—Effect of concentration of poison on the optimum pressure.

Fig. 15—Effect of space velocity on space-time-yield.

as that of a decrease in temperature. At high space velocities the initial drop produced by a low concentration of poison becomes greater, while further increase in the concentration of poison produces less and less effect as the efficiency approaches zero.

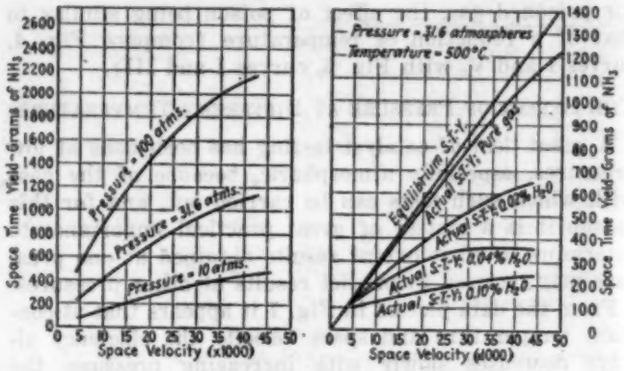
The Effect of Poisons at Different Pressures

The data obtained at different pressures with poisoned gas are scarcely sufficiently uniform to allow definite conclusions to be drawn, but all available data point to the conclusion that the decrease in efficiency produced by a given concentration of poison increases somewhat with increasing pressure. Whether this is true for all temperatures and space velocities cannot be determined from existing data, but it seems probable that the decrease in efficiency with increasing pressure is itself a function of both temperature and space velocity, or more probably, of the efficiency itself.

The Per Cent of Ammonia

The Effect of Temperature at Different Pressures

As pointed out above, the efficiency of NH_3 conversion always increases with increasing temperature, but since the equilibrium percentage of NH_3 decreases with increasing temperature the actual per cent of NH_3 in the gas does not always thus increase. In general, under conditions in which the efficiency is low and increase in temperature produces an increase in the per cent of NH_3, the increase in efficiency more than balances the decrease in the equilibrium value. As the efficiency



FIGS. 16 AND 17

Fig. 16—Effect of rate of flow on space-time-yield with pure gas.

Fig. 17—Effect of rates of flow on space-time-yield with poisoned gas.

approaches unity, however, its increase with increasing temperature is slower than the decrease in the equilibrium value, with the result that a decrease in the per cent of NH_3 results. For any given pressure, space velocity and concentration of poison there will be an optimum temperature, at which the maximum per cent of NH_3 will be obtained from the catalyst under consideration. This optimum temperature is of the greatest importance from an industrial standpoint, as it is an important factor in determining the most economical condition for commercial operation. This optimum (see Fig. 11) is affected by the pressure, the space velocity and the concentration of poison which may be present.

If we compare determinations of the optimum temperature made at different pressures, it appears that the optimum temperature is slowly increased by increasing

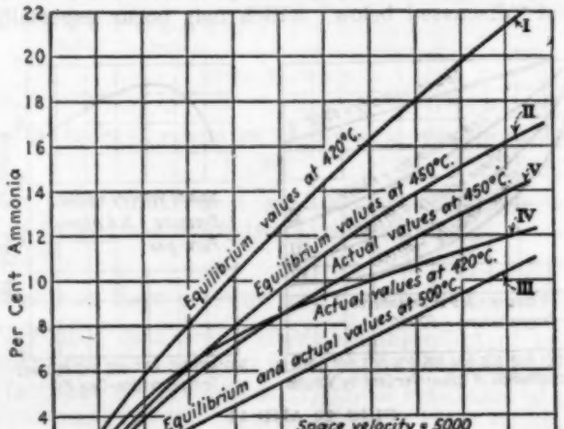


FIG. 18—EFFECT OF PRESSURE ON PER CENT OF AMMONIA AT DIFFERENT TEMPERATURES

pressure. This is illustrated in Fig. 12. Thus in order to obtain the maximum per cent of NH_3 with a given catalyst at a given pressure, the temperature of operation must be somewhat higher at high pressures than at low.

Effect of Temperature at Different Space Velocities

Determinations of the optimum temperature made at different space velocities show that in general at constant pressure the optimum temperature is increased

by increasing the space velocity. This fact is illustrated by the curve in Fig. 13. It follows therefore that the higher space velocity selected for operation the higher the temperature which must be selected in order that the catalyst may give its maximum percentage of NH_3.

Effect of Temperature With Gas Containing Poisons

Since the presence of water vapor or carbon monoxide produces a lowering in efficiency, it is to be expected that the optimum temperature will be higher with gas containing poisons than with pure gas. That this is

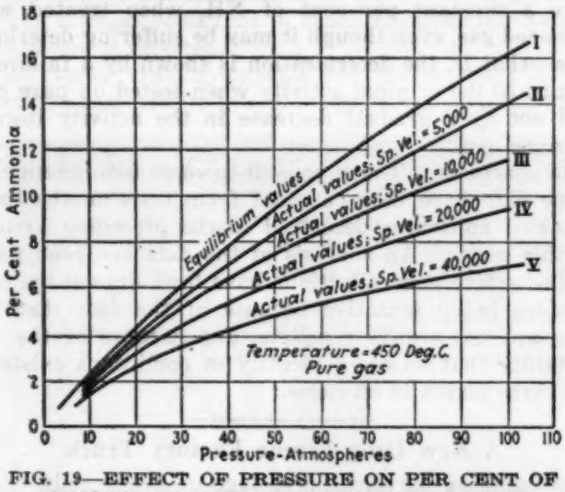


FIG. 19—EFFECT OF PRESSURE ON PER CENT OF AMMONIA AT DIFFERENT SPACE VELOCITIES

the case is shown by the data expressed graphically in Fig. 14, in which it appears that the optimum temperature rises rather rapidly with the concentration of poison in the gas. Thus if the gas contains poisons, it will be desirable to operate at a higher temperature to obtain the maximum output of ammonia than would be the case if pure gas were being used.

The Effect of Rate of Flow of Gas at Different Temperatures

Since an increase in the rate of flow of gas produces in general a decrease in the efficiency (see Fig. 4), at constant temperature and pressure, and since the equilibrium percentage of ammonia is constant under these conditions, it follows that the per cent of ammonia must likewise decrease similarly with increasing rate of flow of gas.

However, if the gas, after removal of the ammonia, is to be recirculated over the catalyst, as will be the case in commercial operation, the fact that the per cent of ammonia does not decrease as rapidly as the space velocity increases becomes of importance. Thus if we consider the space-time-yield (the weight of NH_3 per liter of catalyst per hour) we find that in general this increases with increasing space velocity. Data illustrating the increase in space-time-yield with increasing space velocity, at several temperatures, are expressed graphically in Fig. 15.

Consideration of the curves in Fig. 15 shows that at high space velocities, say 40,000, the yield of NH_3 is greater at 475 deg. C. than at any other of the temperatures investigated, while at 20,000 space velocity 450 deg. C. shows the greater yield, and at 5,000 space velocity the yield is greater at 420 deg. C.

It would appear at first sight that economical commercial operation would require the use of high space velocities, since the weight of ammonia produced per hour by a given mass of catalyst is highest under these conditions. This would undoubtedly be the case if high rates of flow of gas did not entail difficulty and expense. As higher rates of flow are considered, a point will be reached when the increased yield of NH_3 is more than offset by the increased cost of operation. It should be possible by experiment to determine the optimum rate of flow for any given installation.

Effect of Rate of Flow of Gas at Different Pressures

Data showing the increase of the space-time-yield with increasing space velocity at constant temperature and at different pressures are expressed graphically in Fig. 16. The effect of pressure upon the equilibrium values is so great that it masks any other effect, so that the space-time-yields at higher pressures are invariably greater than those at the lower pressures. This is better shown in Fig. 20 and discussed below.

Effect of Rate of Flow of Gas With Gas Containing Poisons

Since, as has been previously shown (see Figs. 9 and 10), the efficiency of NH_3 conversion is lowered at any space velocity by the presence of poisons in the gas and since the equilibrium values are not changed, it follows that the per cent of NH_3 will be correspondingly lowered by the poison, and no further discussion seems necessary. It seems desirable, however, to consider the effect of poison upon the space-time-yield, and data illustrating this effect are expressed graphically in Fig. 17. These data show that the rate of increase of the space-time-yield with increasing space velocity is much greater

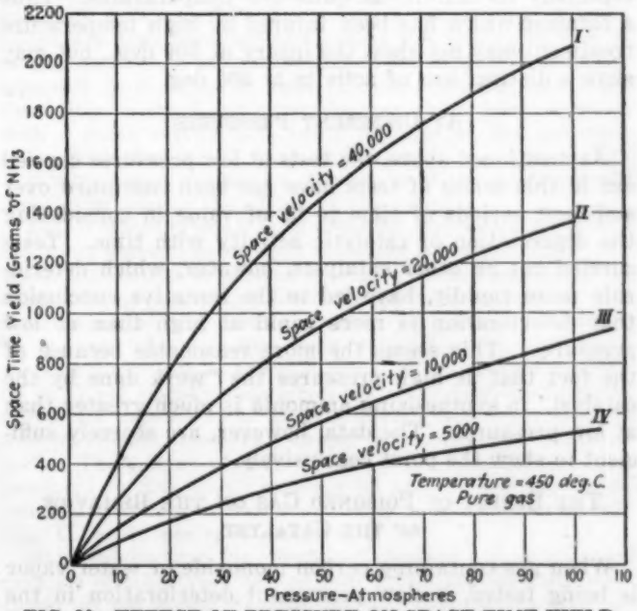


FIG. 20—EFFECT OF PRESSURE ON SPACE-TIME-YIELD AT DIFFERENT SPACE VELOCITIES

with pure than with poisoned gas, so that if high space velocities, say 40,000, are to be employed, thorough purification of the gas becomes more important.

The Effect of Pressure

As indicated above, the effect of pressure upon the equilibrium per cent of NH_3 is so great that an increase in pressure invariably produces an increase in the actual

per cent of NH_3. Figs. 18, 19 and 20 illustrate (*a*) the effect of pressure upon the per cent of NH_3 at different temperatures, (*b*) the effect of pressure upon the per cent of NH_3 at different space velocities, and (*c*) the effect of pressure upon the space-time-yield. Discussion of the curves seems unnecessary. Data on the effect of pressure with poisoned gas are insufficient to permit more detailed conclusions than that the rate of increase of the per cent of ammonia, or of the yield, with increasing pressure is in general much less for poisoned gas than for pure gas.

The Effect of Poisons

Since the presence of poisons does not affect the equilibrium values in any way, the per cent of NH_3 will decrease with increasing concentration of poison in exactly the same way that the efficiency decreases. Since this is illustrated above (Figs. 9 and 10), further discussion seems scarcely necessary.

The Change in the Behavior of the Catalyst With Time

At Different Temperatures

When pure gas is being tested the activity of the catalyst is apparently unaffected by prolonged treatment at temperatures not exceeding 550 deg. C. The tests at 1, 10 and 31.6 atmospheres are usually of only a few days duration at most, and are therefore inconclusive; but the tests at 100 atmospheres are frequently extended over 6 weeks or more, and it is characteristic of the type of catalyst under discussion that its activity is unimpaired at the end of that time, provided the temperature has not exceeded 550 deg. Temperatures above 550 deg. are apt to injure the activity of the catalyst, especially its activity at quite low temperatures. Thus a catalyst which has been injured by high temperature treatment may not show the injury at 500 deg., but may show a distinct loss of activity at 400 deg.

At Different Pressures

As mentioned above, the tests at low pressures carried out in this series of tests have not been continued over sufficient periods of time to be of value in considering the depreciation of catalytic activity with time. Tests carried out on other catalysts, however, which deteriorate more rapidly, have led to the tentative conclusion that deterioration is more rapid at high than at low pressures. This seems the more reasonable because of the fact that at high pressures the "work done by the catalyst" in synthesizing ammonia is much greater than at low pressures. The data, however, are scarcely sufficient to show the point conclusively.

The Effect of Poisoned Gas on the Behavior of the Catalyst

When gas containing carbon monoxide or water vapor is being tested, a slow permanent deterioration in the activity of the catalyst occurs—that is, the catalyst does not regain its original activity when again tested with pure gas. This is illustrated by the data in Table IV.

TABLE IV—RECUPERATIVE POWER OF CATALYST

Pressure, Atm.	Temperature, Deg. C.	Per Cent NH_3	Efficiency	Gas
100	450	14.31	0.878	Pure
100	450	6.04	0.309	0.05 per cent CO
100	450	12.26	0.708	Pure gas after CO treatment for 20 days
100	450	2.13	0.130	0.1 per cent H_2O
100	450	11.00	0.600	Pure gas after CO and H_2O treatment for 31 days.

The permanent deterioration produced by the poison is probably greater the higher the concentration of poison, the longer the time of treatment, the higher the temperature and the higher the pressure. At low pressures (10 to 31.6 atm.) complete recovery of the catalyst may follow several days treatment with poisoned gas, but at 100 atmospheres the original activity is scarcely ever regained.

The available data do not enable us to determine whether or not the progressive deterioration would continue indefinitely or whether it would approach some limiting value with continued testing. Indications favor the latter presumption, since the catalyst will usually give a constant per cent of NH_3 when treated with poisoned gas, even though it may be suffering deterioration—that is, the deterioration is shown by a failure to return to the original activity when tested on pure gas, and not by a gradual decrease in the activity toward poisoned gas.

In conclusion, it may be well to emphasize again that these data have been collected from tests on the three types of apparatus described in the preceding articles of this series. An analysis of the data has been made and tentative generalizations have been drawn, the conclusions being tentative because of the fact that the data are not always complete, and because of the uncertainty that an exact identity of conditions exists in the three plants in all cases.

A New Drop Frame Factory Truck

In handling barrels, bales, bags or heavy rolls, there has been a demand for an especially low loading platform electric truck. The Elwell-Parker Electric Co., of Cleveland, Ohio, has produced, and has had in operation for some time, a truck built up of 95 per cent standard

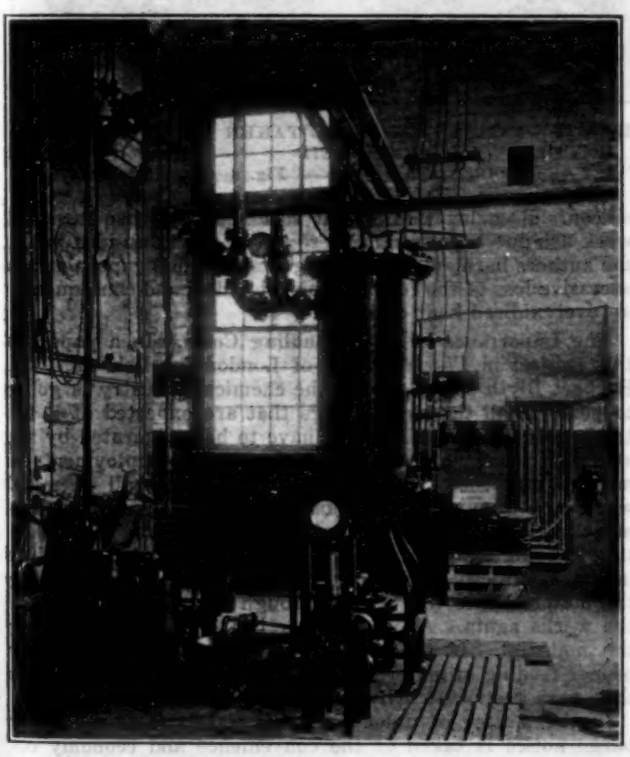
DROP FRAME FACTORY TRUCK WHICH SOLVES MANY PROBLEMS

parts on special frame. This equipment offers the solution to many annoying trucking problems, where hauls are so long that a man with a hand truck is too slow and expensive a means for the movement of materials. This truck carries a storage battery on the upper deck with motor and worm drive axle beneath. All four wheels steer. The "kick-up" on platform houses the rear wheels. Drive wheels are fitted with 21½ x 3½-in. rubber tires and the trailing wheels with 10½ x 5-in. tires. The truck will operate 15 to 20 miles on a single battery charge.

Electric Steam-Generator

AN ELECTRIC steam-generator utilizing the principle of heating produced by resistance to flow of electric current through water has recently been placed on the market by the Electric Furnace Construction Co., Philadelphia, Pa. In this apparatus steam is generated by high-tension alternating current led through the water to be evaporated by means of electrodes, placed in a vertical tank. The quantity of steam produced, the pressure at which it is generated and the consumption of current are governed by the height of the water in this tank, control being obtained through standard valves. Due to the elimination of the firebox and boiler setting, a great reduction in space required per boiler-horsepower is effected.

Any water that is suitable for the ordinary boiler is satisfactory and it is not necessary to install water-softening apparatus, as the salts in the water settle out as a sludge at the bottom of the tank instead of forming a scale, as in the ordinary type of boiler. This is because no part of the boiler is at a higher temperature than that of the steam. Corrosion is also eliminated for the same reason. The only part subjected to much wear is the electrode, which may be easily and cheaply renewed.



ELECTRIC STEAM-GENERATOR INSTALLED AT PLANT OF CANADIAN ELECTRO PRODUCTS CO.

The most important application of the electric steam-generator[1] is in industries located within the range of hydro-electric power plants, where use may be made of surplus power or "spillway" power. It is also possible in some cases to use the excess power at off-peak loads for generating steam and to store this supply of heat or utilize it when available, as a parallel to coal- or oil-fired boilers, thus reducing the fuel consumption. Conditions such as this occur at many paper and pulp mills, and in many other industries. In some districts where fuel is expensive and water power is available the complete substitution of electric steam-generators for boilers heated by other means should prove economical. Under such conditions similar electric steam-generators have already had wide and successful application in Italy, France, Switzerland, Norway and Sweden.

[1]Readers interested in the subject of electric steam-generation may find the following recent journal articles of value: *Engineering*, Feb. 6, 1920 (Revel and Brown-Bouveri type); *Power*, Oct. 12, 1920 (Swiss practice), March 8, 1921 (French practice—Revel type), May 10, 1921 (Swedish installation at Wärgon); *Electrical World*, Aug. 20, 1921 (Brown-Bouveri type), Nov. 19, 1921 (Swedish Forssblad type), Feb. 12, 1921 (Swiss practice—Revel type); *Power Plant Engineering*, Feb. 15, 1921 (Swiss practice—Revel type); *General Electric Review*, June, 1920 (general report); *Can. Chem. & Met. Eng.*, March, 1922 (installation at Shawinigan Falls).

Synopsis of Recent Chemical & Metallurgical Literature

Crystal Structure of Solid Solutions.—Using the X-ray spectrometer in the manner described in CHEMICAL & METALLURGICAL ENGINEERING, vol. 25, p. 657 (Oct. 5, 1921), and vol. 26, p. 82 (Jan. 11, 1922), Edgar C. Bain reported the results of studies on the "Crystal Structure of Solid Solutions" before the February meeting of the American Institute of Mining and Metallurgical Engineers.

The binary system Cu:Ni is of uninterrupted solid solutions. Since both these metals, when pure, crystallize in the face-centered cubic arrangement and have very similar dimensions (3.60 and 3.54 Angstroms respectively), the space lattices of the intermediate alloys should show the minimum distortion. Investigation of annealed specimens bears this out. All the alloys are face-centered cubes; the size decreases gradually with increasing nickel, an effect exactly similar to the change in a crystal space lattice with temperature.

Gold-copper alloys behave similarly, despite the great difference in size of their crystalline units (face-centered cubes of 4.08 and 3.60 Angstroms respectively). All the alloys are true face-centered cubes; the change in size is mostly confined to the middle half of the range. Thoroughly annealed 75:25 alloys in both of these systems gave some faint lines in the X-ray crystallogram which were identified with a cubic system just twice the size of the dominant one. Evidently this is what should occur in a 3 to 1 alloy if it were homogeneous—i.e., the atoms of the solute equally distributed among the atoms of the solvent.

Metals which crystallize in different crystalline types and yet form uninterrupted solid solutions act differently. The dominant partner or solvent absorbs a certain amount of the other with no measurable distortion of its space lattice. For instance nickel (face-centered cubic; 3.54 Ang.) will absorb 65 per cent of chromium (body-centered cubic; 2.90 Ang.) without distorting its space lattice. Alloys containing from 65 to 95 per cent Cr show space lattices of *both* constituents; chromium appears to be able to absorb only 5 per cent Ni into its normal structure. Copper and manganese act similarly. There is an overlap (where both crystallograms are produced in one alloy) between 60 and 90 per cent manganese. This series has a minimum melting point at 870 deg. C., at 30 per cent manganese.

Bain thinks that this "overlap" denotes the presence of crystals of both types (either pure metal or conjugate solutions) in the metal, despite the fact that microscopic examination shows only one phase. Annealed samples show a very coarse grain, and the dominant partner gives a "dashed" crystallogram characteristic of large crystals. The other metal simultaneously prints a finely penciled set of lines characteristic of a fine-grained sample,[1] and possibly exists in sub-microscopic particles.

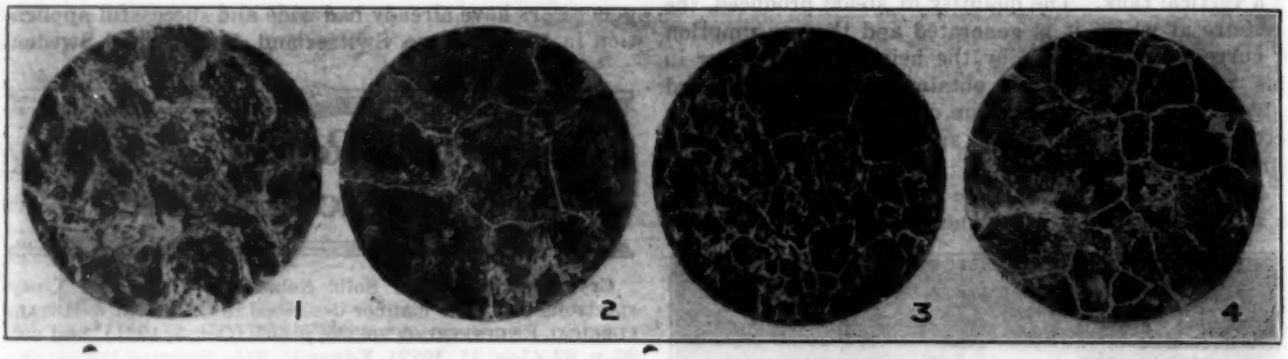
Iron-nickel alloys exhibit the effect of allotropy. Alpha iron is body-centered cubic (2.86 Ang.) whereas gamma iron is almost exactly like nickel (face-centered cubic, 3.54 Ang.).

[1]"Mixed Orientation Developed in Crystals of Ductile Metals by Plastic Deformation," by Bain and Jeffries, CHEM. & MET. ENG., vol. 25, p. 775 (Oct. 26, 1921).

Alloys up to 25 per cent nickel, even if annealed, show only the crystallogram of alpha iron. However, if the gamma state in iron is preserved by quenching, the pattern due to nickel is exhibited nearly to pure iron.

Soft Spots After Case-Hardening.—H. W. McQuaid and E. W. Ehn, metallurgists for the Timken Roller Bearing Co., presented an important paper before the February meeting of the American Institute of Mining and Metallurgical Engineers on "Effect of Quality of Steel on Case-Carbonizing." In the manufacture of roller bearings, the parts, made of low-carbon steel, are carburized and heat-treated with the utmost care and under strictest control, so as to produce greatest uniformity in the product. Yet often whole heats would show nearly 100 per cent rejections on account of soft spots discovered when testing the hardened pieces with a file. Chemical analysis failed to show any differences from other heats which acted properly, nor was the carbon in the case materially lower. Special attention to the cementation and hardening did not remove the trouble, nor did recarburization or change in the cement help any. Samples of this "off" steel, when packed in the same box with other steel known to be normal as far as carburization was concerned, would still be soft at final inspection, although the comparison pieces hardened perfectly.

It was found that the behavior on hardening could be predicted by microscopic examination of the carburized pieces, as indicated in Table I. A good case is shown in Fig. 4, while a bad one is shown in Fig. 1.



FIGS. 1 TO 4—HYPEREUTECTOID ZONE IN FORGED TEST INGOTS OF ELECTRIC STEEL TAKEN FROM VARIOUS TIMES DURING THE HEAT. × 70. ETCHED WITH PICRIC ACID

Fig. 1—Charge just melted. Fig. 2—Second slag made up. Fig. 3—Ferrosilicon added. Fig. 4—Finished heat.

TABLE I—MICROSTRUCTURE OF GOOD AND BAD STEELS

Zone	Good Steel	Bad Steel
Hypereutectoid case	Large uniform pearlite grains	Small pearlite grains
	Uniform thin Fe_3C network	Massive Fe_3C films
Eutectoid zone	Deeper and thicker than in bad steel	Surrounded by ferrite Shallower and thinner than in good steel
Hypoeutectoid zone	Coarse crystalline Continuous bold ferrite network	Isolated fine ferrite areas
Core	Normal angular pearlite areas	Banded ferrite and with ghost lines

Pieces from each stage of manufacture were carburized, and a defective steel proved a poor carburizer back to the ingot. It was therefore concluded that the trouble originated in the furnace. It has been Messrs. McQuaid and Ehn's practice, therefore, to pour a small ingot at the middle of each cast, forge it down to a bar, and heavily carburize this bar. If the cementite near the surface appeared in divorced masses, the heat would not be accepted. Co-operation on the part of the steelmakers was obtained after the Timken company had demonstrated that this test was able to segregate a group of samples submitted by the steel company with secret marks and from heats some known to be bad, others known to be correctly made with great care.

While the exact mechanism of the pearlite divorce is unknown, it is thought by the authors to be a characteristic of oxide included in the metal. For instance, fairly good steel may have a ghost line here and there, and this ghost line will persist throughout carburization and be the locus of divorced cementite. No phosphorus bandings are developed in such steel by cupric reagents—indeed, 24 hours at 925 deg. C. in the carburizing pot should give ample time for equalization of soluble phosphides. If the surface of a small ladle of molten electric steel—a steel which carburized perfectly—is blown slightly with oxygen gas, that sample when carburized shows a complete breakdown of pearlite into massive ferrite and cementite. Figs. 1 to 4 show samples taken from an electric furnace at various times during the heat—it is evident that the microstructure of the case is not correct until after the charge has been deoxidized with ferrosilicon. Brearley thinks that soft spots on case-hardened work are due to low manganese in the stock, an idea which the authors harmonize by saying that low manganese means excessive loss of the ferro or spiegel added, and consequently an overoxidized heat of metal.

The Importance of Low Handling Costs.—In a paper on this subject in *Chemical Age* of London for Feb. 25, 1922, Herbert Blyth states that if the chemical industry is going to perform all the great things that are expected of it for the benefit of mankind, it will have to be invigorated by the sweeping away of inefficiencies and the employment of modern methods. He states that in nearly all chemical works the want of efficient unloading and conveying equipment is one of the chief causes of the high cost of production, it being an established fact that the cost of the product is almost directly proportional to the cost of simply moving the material into the works, through the plant, and out of the works again. Another factor is the speed of handling the material. If production is kept at full capacity by proper feeding of materials, cost will naturally be much less than with restricted delivery of material.

In the matter of unloading bulk materials from car or barge notice is taken of the convenience and economy obtained through the utilization of pneumatic methods. The advantage of this method lies in the continuous nature of the duty performed and the elimination of hand labor in trimming; but the method can be used only for a practically dry and fairly fine material. For coarse or moist materials the crane and bucket unloader is recommended.

For handling from the unloading point the belt conveyor is recommended when the route is straight, unobstructed, and not too long. For heavy material, or material discharged into a pit by bottom dump cars, which involves a lift as well as a horizontal movement, the monorail carrier is recommended. The final choice of the handling method used must rest on a study by the chemical engineer, the mechanical engineer and the financial man of the material to be handled, its tonnage, and the route over which the handling is to be done, together with the cost of the various methods available.

In conclusion, it is stated that the chemical industry has not hitherto properly investigated its handling problems or taken serious notice of the improved equipment available. The objects of every industry are to cut production costs, increase output and improve plant conditions, and a great deal can be done toward the achievement of these objects by the adoption of suitable methods of handling the raw materials and products.

Book Reviews

STEEL MILL BUILDINGS. Fourth Edition. By *Milo S. Ketchum.* New York: McGraw-Hill Book Co., Inc. Price $6.

In this book is found an old friend in a new flexible cloth binding well suited to constant and hard usage. The author has re-written much of the book and added a considerable amount of subject matter and many instructive drawings and diagrams, including very valuable data on a number of proved building materials developed since the earlier editions of this book, and a large variety of the newer type of building construction. In the preparation of drawings and diagrams, the work has been carried out in an exceptionally neat, orderly and well-arranged manner, using plain lettering of nearly uniform character throughout the book and offering a very excellent example to the student during his habit-forming years.

It is doubtful if some of the tables, those also found in the handbooks published by various steel companies, will prove of much value to or be often used by the experienced engineer, but since the work is also offered as a text book for students, they may well serve a useful purpose.

Special credit is due the author for putting in concise form the analysis of stresses in statically indeterminate structures of a wide variety, a subject hitherto involving so much sifting of chaff from the wheat that the busy engineer has shown a marked tendency to avoid many useful forms of structures entailing such calculations. L. W. EMERSON.

* * *

CONDENSED DESCRIPTION OF THE MANUFACTURE OF BEET SUGAR. By *Franz Murke, Ph.D., A.M.* 5 x 8¼, v + 175 pages. New York: John Wiley and Sons, Inc., 1921. Price $2.50 net.

Dr. Murke's book directs more attention to the principal operations of beet-sugar factories than to the equipment used. This is an excellent feature. Another good feature is the running commentary on the mistakes and difficulties commonly encountered, including methods of avoiding or overcoming them. In this latter the author gives us a liberal helping from his own store of wisdom accumulated through years of experience and comparative study of the operations of several factories. The style is very concise and usually clear, but the brevity has been carried to the extremity of omitting illustrations, diagrams and even tables of analytical data showing the successive changes in the products as they advance through the process. The book therefore is addressed (in the preface) especially to readers who already have a respectable knowledge of the process. But since there is very little about the relations of the various operations one to another or to the process as a whole, one of its greatest potential values has not been developed. Treatment of the operations in flow-sheet sequence was perhaps thought sufficient.

Although the book was mainly written several years ago, it has been brought generally up to date. Some exceptions to this are the omission of modern devices applied to the cleaning and handling of beets, the recommendation of daneks for thin juice filtration (p. 50) and the treatment of reactions from the standpoint of the old chemistry rather than of modern colloidal and physical chemistry. The discussions of such obsolete practices as the bluing of sugar (p. 91) and the osmose process take up space that could have been given to more valuable features.

There is little to stimulate new thinking, or to indicate lines of probable future development. The style is usually one-sided and conservative. Some poorly constructed sentences and numerous awkward or half-Anglicized expressions such as "after-purification," "healthy juices," "maishing," "wagons . . . carried on rails" (for "dump-cars"), etc., mar the usual perspicuity. The frequent allusions to European practice would be more valuable if they were complete enough to give the reader a clear idea of what is most general there and how it differs from American practice.

The absence of an index will discourage the use of the book as a handbook. There is no bibliography or other guide to the literature of the subject of beet-sugar manufacture or of the individual operations used, and Claassen is the only other authority cited. The six tables and two or three formulas making up the last chapter are useful, but it would seem desirable to have included also some equally useful but less readily available data.

The book is very readable and should prove valuable to chief chemists, foremen and others who are in the stage of secondary training in the subject and interested especially in the operation rather than in the engineering side of it. In fact, it is surprising on the whole how much useful information of this type is included in the 155 pages of text proper. In some respects the treatment is often better than in most other books on the same subject. For example: (1) Without saying so, the author shows that the diffusion process is ordinarily one of continuous extraction with intermittent charging of fresh beets and discharging of exhausted pulp and that it is not intermittent counter-current extraction as some books would lead one to believe. (2) The saving in steam and condenser-water by the application of vapor-heating is shown. (3) The starting, operation and closing down of a limekiln is described so simply and yet so definitely that anyone who has read it would probably not make such blunders as we sometimes hear about in connection with this station.

Aside from the texts prepared by some of the sugar manufacturers for the instruction of their employees, which, however, are not readily available, it is the best book on American practice. M. J. PROFFITT.

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JOURNAL OF THE INSTITUTE OF METALS, vol. 26. Edited by *G. Shaw Scott.* 8vo. 760 pages. London: The Institute, 36 Victoria St., S.W.1. Price 31s. 6d.

Again the British Institute of Metals is to be congratulated upon a very attractive and useful book, published and in the hands of their members within 5 months after the autumn meeting. It contains not only the technical papers presented at that time, and 120 pages of discussion thereto, but the May lecture on "Casting of Metals," by Prof. Thomas Turner, 200 pages of abstracts from current metallurgical periodicals, and a considerable mass of society news. Indeed, the bulk of the volume is growing apace. However, in the opinion of the reviewer, the present volume could be compressed by 100 pages, partly by elimination of matter of purely temporary interest and which, on this side at least, would be placed in the hands of the membership through bulletins or circulars, and the remainder through a typographical rearrangement of the index.

A continuation of the notable papers on light alloys is noted in an extended discussion of constitution and age-hardening of Al:Mg:Si alloys by D. Hanson and Marie Gayler. Most of the other papers deal with the properties of worked metal (pure copper and zinc) cold drawing of bronze, and extrusion. G. D. Bengough also adds a summary of the findings of the Corrosion Committee, having special reference to methods which may be adopted to minimize corrosion of brass condenser tubes. Laboratory men will be interested in the papers on electro-etching and scleroscope tests on thin specimens. New copper alloys of promise with up to 8 per cent nickel and 10 per cent aluminum are discussed by A. A. Read and R. H. Greaves. Foundry practice is touched upon in papers on the effect of lead in Admiralty mixture, and the density of brasses. In this vein, R. Genders presented a very interesting note on the casting of brass ingots, wherein he notes that rejections due to pipe and inclusions in hollow drawn 70:30 brass articles were reduced from 25 per cent to nearly zero by using best steel-teeming practice. Long narrow ingots, 1½ in. square, 6 or 7 ft. long, were replaced by others 30 in. long, tapering from 3½ to 3 in. square. These were set big end up, the top surmounted by a hot fireclay top, a "dozzle," and the teeming slowed down so that when cast the ingot was solidified and much colder at the bottom than at the top. E. E. THUM.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Week's Testimony in Dye Investigation Brings No Substantiation or New Developments

The sensational developments which rumor had promised would be disclosed when the testimony of dye importers was heard before the Senate sub-committee have apparently fallen as flat as Senator King's original charges. The testimony of Herman A. Metz, importer and manufacturer, disclosed nothing more startling than a personal animosity between himself and Francis P. Garvan, former Alien Property Custodian.

For the rest, the King charges have been somewhat lost in the shuffle of witnesses entering an eleventh hour agitation for tariff protection. Charges and counter-charges which have characterized the entire investigation promise to pass into the record without substantiation. Senator Shortridge's comment on some of Mr. Metz's statements to the effect that his statement was "argument and inference" drew from the latter a reply which seems to summarize the situation. "That's all we've had from either side," said Mr. Metz.

Metz Continues Reading of Testimony

The testimony of Mr. Metz occupied four days of the hearing. He began the reading of his lengthy statement on March 23 and concluded March 29. In his testimony, Mr. Metz went into the details of his troubles with the Alien Property Custodian and attempted to defend his stand in opposition to the dye embargo. He seemed very bitter in his resentment of the action brought against him during the war by F. P. Garvan, declaring that the latter "sought to ruin me in the interest of those in whom he was interested."

"I was evidently German when it suited his purpose," he stated, "but was 100 per cent American when I took stock in his Chemical Foundation or was granted licenses by the Foundation under patents they claimed to own."

He had refused to surrender the stock of H. A. Metz & Co., and the H. A. Metz Laboratories, Inc., upon demand of the Alien Property Custodian, Mr. Metz said, and had obtained a temporary injunction in New York enjoining the Custodian from taking any action on the stock of those companies. Metz had instituted proceedings to recover the stock of the Farbwerke-Hoechst Company.

He had consulted Charles E. Hughes, now Secretary of State, he said. "Pending a hearing on the temporary injunction, Garvan tried to arrange by stipulation just under what conditions I was to deposit the stock, because I told Judge Hughes I positively refused under any condition to allow Garvan to put his directors into my salvarsan plant and if he did, I would close the plant and take every man out.

"Various stipulations were suggested but I refused them, all of them, even when Judge Hughes told me I was running risk of being indicted, as under the Alien Property Custodian law his determination was sufficient, and I had redress under section 9. I realized there was no redress after once my property had been taken. I had been damaged enormously by the reports of Garvan's seizure and the stories circulated by my competitors about being German, all of which was enough to condemn anyone in those days."

Criticizes Institute and Foundation

The witness brought Judge J. Harry Covington, a former member of Congress from Maryland, and now counsel for the American Dyes Institute, into his testimony, declaring that he had been active before Congress in support of embargo legislation for American dye manufacturers.

Mr. Metz went into much detail concerning his relations to the American Dyes Institute and the Chemical Foundation. He charged that the principal activities of the first had been in obtaining legislation and said that the second "posed as a quasi-public organization, whereas there is nothing public about it."

Mr. Metz told in detail of his manufacture of salvarsan, declaring that the service he had rendered in this connection would have been rendered if the Chemical Foundation, which holds a patent for its manufacture, had never been heard of, as he manufactures under a patent from the Federal Trade Commission.

In answer to questions from Chairman Shortridge, the witness declared himself in favor of protecting the domestic manufacture of salvarsan by an ad valorem rate of 50 or 60 per cent plus a specific duty.

"A specific rate of 7 to 10 cents a pound would protect us on dyes, but not on salvarsan," he said.

Touching on the value of the patents taken over by the Chemical Foundation, Mr. Metz declared that the salvarsan patent was "worth a million dollars to anybody"; that the indigo patent was very valuable and that the patents of the Bayer Co., seized and sold during the war, were worth several millions. Mr. Garvan, as Alien Property Custodian, knew that they were worth "a great deal more" than the $250,000 paid by the Chemical Foundation, he added.

The witness attacked the policy of the Dermatological Research Institute of Philadelphia. Although not run for profit, he said, the Institute sells its product in the open market in competition with those manufacturing for profit. The difference is, according to the witness, that he had to pay taxes to the government on his profits while the Institute did not. He declared that the Institute had made $500,000 in profits from its manufacture and had "presented" this to itself, not for profit, but for further research work.

No Dye Monopoly, Says Metz

"There is today no monopoly in the American dye and organic chemical industry, but the strongest kind of competition; everybody is trying to turn stocks into cash," Mr. Metz declared. "Banks are calling loans on stocks of dye companies," he continued, "prices are falling and you know when that is going on there is no monopoly."

He estimated that about twenty of more than eighty plants making dyes and chemicals in this country have been forced to close because of decreased consumption and competition. He declared that he had done everything possible to help the American industry, as he wished to see it prosper.

Tariff Would Protect Manufacturers

In answer to questions from the chairman, Mr. Metz said that a tariff can be written which would protect adequately 75 per cent of the dye products made here. The protection should be 50 per cent ad valorem and from 7 to 10 cents a pound specific duty on dyes and the same duties on intermediates. "With that protection, I'll guarantee that my plants will run and make all the products they make today," he added.

Mr. Metz said he had no criticism to make of the men in charge of the licensing system and that it had been administered fairly and well, but he objected to the system as inconvenient and costly to consumers of dyes. He said he was speaking solely in the interests of the consumers.

Textile Man Favors Embargo

Franklin W. Hobbs of Boston, president of the Arlington Mills, Lawrence, Mass., was the first witness following Mr.

Metz. Mr. Hobbs explained that his mills manufacture worsteds used in men's and women's wear and dye 350,000 yards a week. He announced that he would discuss the question of what is needed for adequate protection of the American dye and organic chemical industry as an American citizen and as a large consumer of dyes.

The substance of his testimony was an expression of confidence in the ability of American dye manufacturers to meet the needs of the textile trades if given proper protection. "We have no complaint to make whatever of American dyes. We use a few foreign dyes, for fancy shades, but I believe these shades will soon be made in this country," he said.

Mr. Hobbs expressed himself in favor of the licensing system, saying: "If we want to be absolutely sure about protection, we're going to get results with the licensing system. You may get it with a tariff, but we are sure of getting it with the licensing system."

H. J. Conn of the Agricultural Experimental Station at Geneva, N. Y., said the American scientific men are interested in the maintenance of the American dye and chemical industry, regarding it as necessary to proper research work. He said about ten American manufacturers have standardized their colors for biological research work. This witness had no opinion to offer as to the best means of protecting the American industry.

Schamberg Defends Dermatological Institute

Dr. Jay Frank Schamberg, director of the Dermatological Research Institute, Philadelphia, commented vigorously on testimony relative to his institution, given by Mr. Metz. Dr. Schamberg said he was at a loss to understand just what Mr. Metz meant by his statement. He said that if Mr. Metz meant that Dr. Schamberg and his associates turned over to an institute incorporated for philanthropic and scientific purposes money which they could legally have retained for themselves, Mr. Metz was correct, but that if he meant that one penny was retained for the personal profit of Dr. Schamberg or his associates, the statement was "a miserable and damnable calumny."

The witness explained that the Dermatological Research Laboratories were established in Philadelphia in 1912, through the generosity of P. A. B. Widener of Philadelphia, who financed their scientific work for four years. After his death further support from this source stopped. These laboratories, the witness explained, were engaged during this period in research work to develop new chemical compounds to combat germs causing infectious diseases.

Continuing, he went into the relations of the Laboratories with Mr. Metz during the war when there arose an urgent need for salvarsan. The primary purpose of his organization in manufacturing salvarsan was to meet this shortage, lower the price to the poor and supply physicians and hospitals. He believed, he said, that these purposes have been fulfilled, as the American product is selling today at about one-fifth the price the Germans received here for their product before the war, and the American product today is the superior, he declared.

"If the German product were allowed to come in, I believe the Germans would be able to close most of our laboratories by price competition," said Dr. Schamberg.

The witness explained that the production of salvarsan is only one of the activities of the Institute, which, he said, is constantly carrying on research work to discover drugs to cure infectious disease and has done so. All profits must be, he said, devoted to the research work.

Helium Research to Continue Despite Opposition

During consideration of the army appropriation bill by the House, Representative Green of Iowa sought to terminate experiments on helium. He took the position that it is not necessary to recover helium, as dirigibles are going out of use. Representative Lanham of Texas defended appropriations for conservation of helium. An amendment by Mr. Green to discontinue the investigation by striking from the bill authorization to acquire land to explore, procure or reserve helium gas as carried by the bill on committee recommendation was rejected, however.

Utilization of Water Power at Muscle Shoals by Haber Process Is Proposed

The Secretary of War has received a proposal for the purchase and operation of some of the Muscle Shoals property from Dr. Charles L. Parsons, representing a group which will organize a company called the Southern Nitrate Corporation. The company will be organized, if the proposal is accepted, and will in turn organize a corporation, the securities of which will be offered to the public.

Details of the Proposal

The company proposes to purchase the first 100,000 kw. of secondary horsepower developed at the Muscle Shoals Dam at a price of 0.75 of a mill.

It offers to purchase Plant No. 1 for $600,000, the purchase price to include everything except the designs acquired from the General Chemical Co. over which the government has jurisdiction. As a condition of the purchase the company will demand the option to lease the carbide plant, part of Plant No. 2, for $50,000 per annum and the option to purchase the Waco quarry property for $200,000 or to lease it for $20,000 per annum.

The company will agree to operate Plant No. 1 as an air nitrogen fixation plant, using as much of the power as is necessary to produce hydrogen for the ammonia process by electrolysis. It further agrees to produce calcium carbide or phosphoric acid and potash by electrothermal methods in the carbide plant. It will maintain a research laboratory and keep all leased property in good condition for the use of the government in case of emergency. It will also agree, in case the government leases the rest of the cyanamide plant, to supply the lessee with calcium carbide at 6 per cent profit as well as nitrogen and power at cost.

Advantages of the Haber Process

In presenting the proposal Dr. Parsons pointed out that the decreasing importance of the cyanamide process for nitrogen fixation was due to the rapidly increasing success of the Haber process. Already the General Chemical Co. has a very successful plant in operation at Syracuse, N. Y. A large plant for producing 100 tons of fixed nitrogen per day is under construction at Billingham, England. Prof. Claude has constructed a remarkable plant in France which operates on the same principle but under much higher pressures. In Italy and Japan similar plants are under construction. Finally, a large cyanamide plant in Odda, Norway, almost half as large as Muscle Shoals, was sold for the equivalent of $10,000, which is scrap value. This Norwegian company plans to install a Haber process plant. All of these data were presented with a view to substantiating the claim that the Haber process is more desirable than the cyanamide process—a better commercial possibility. This particular point has been the subject of a very important controversy which originated in the discussion of the Henry Ford offer.

The company which will be organized by Dr. Parsons is in no way connected with any of the other parties who have made proposals on the Muscle Shoals project. It is not primarily interested in the "philanthropic production of fertilizer," but claims to be a business organization organized to develop a profitable industry.

Such a plant, it is claimed, will be able to produce enough nitrogenous fertilizer at a relatively low cost to stabilize the price of the commodity in this country and lower the cost to the consumer. In addition to fertilizer it is planned to produce calcium carbide and acetylene for autogenous welding. Finally, if development work indicates that the process will be successful, phosphoric acid and potash will be produced by electrothermic methods in some of the carbide furnaces.

Date of N. J. Society Meeting Changed

The April meeting of the New Jersey Chemical Society will be held on the 17th, instead of on the second Monday as usual. The speaker will be Prof. W. D. Harkins of the University of Chicago, who will talk on "Isotopes and the Building of Atoms."

Revival of Patent Convention With Germany Delayed—Working Clause Proposed

The President is understood to be satisfied that it would be unwise to revive the patent convention of 1909 with Germany. The Senate recently authorized the President to revive this patent convention, but it is believed that the Senate action was taken without a thorough understanding on the part of most members that it would exempt German patents taken out in this country from any working clause that might be enacted. The convention also exempts American patents registered in Germany from any working clause which might be adopted in that country. There are certain American industries which are very anxious to have that safeguard, but the arrangement would be particularly harmful to the chemical industry.

The whole matter of a patent working clause is to be threshed out at once. Senator Stanley of Kentucky has introduced a bill which has been approved by the War Department. Public hearings on the bill have been called for April 5. The salient feature of the Stanley bill provides that "any patent or patents issued to any person or persons under the provisions of this act shall contain a proviso to the effect that if such patent so granted is not worked or put in operation so as to result in actual production in the United States of the article embodied in such patent in reasonable quantities within a reasonable time from the date of its issue, which in no case shall be less than 2 years nor more than 5 years, the United States reserves the right to license any person or persons for purposes of manufacture in the United States, and to use and sell the subject matter thereof subject to the conditions hereinafter provided."

In all probability the definition of a reasonable time will be altered so as to leave it to the discretion of the administrative officer.

Societies Co-operate in Work on Corrosion Under Committee of National Research Council

The National Research Council recently appointed a committee connected with its Division of Research Extension with the following membership:

W. M. Corse, chairman, Monel Metal Products Corporation, Bayonne, N. J.; Wilder D. Bancroft, Cornell University, Ithaca, N. Y.; John Johnston, Yale University, New Haven, Conn.; G. K. Burgess, Bureau of Standards, Washington, D. C.; D. M. Buck, American Tin Sheet & Tin Plate Co., Pittsburgh, Pa.; William H. Bassett, American Brass Co., Waterbury, Conn.; E. M. Chamot, Cornell University, Ithaca, N. Y., and Colin G. Fink, 101 Park Ave., New York City, secretary.

The purpose of this committee is to serve as a general clearing house and to devote its attention essentially to fundamental scientific study of corrosion. This committee desires to get in touch with all the work that is being done on corrosion whether through societies, associations, institutes, universities or private or industrial laboratories.

Various Societies Have Corrosion Committees

The American Society for Testing Materials has had a committee on corrosion of iron and steel for a number of years, known as Committee A-5. J. H. Gibboney, chemist of the Norfolk & Western R.R., Roanoke, Va., was designated as acting chairman of the committee, following the death of Dr. S. S. Vorhees of the Bureau of Standards, and the secretary is J. A. Aupperle, chief chemist of the American Rolling Mill Co., Middletown, Ohio. The committee is representative of both non-producers and producers of iron and steel, with four sub-committees, one an advisory committee, another a committee on preserving metallic coatings of metals, another a committee on inspection and the last a committee on total immersion tests. It has been decided to establish a further committee (Committee B-3) on corrosion of non-ferrous metals and alloys, representing non-producers and producers.

The American Committee on Electrolysis was organized in 1913 through the activity of some members of the American Institute of Electrical Engineers, representing, in addition to the Institute and the Bureau of Standards, the following organizations: American Electric Railway Association, American Gas Association, American Railway Engineering Association, American Telephone & Telegraph Co., American Water Works Association, National Electric Light Association, National Gas Association of America. This committee is made up of twenty-seven engineers, three from each of the organizations named. This general committee appointed a special research sub-committee of which H. S. Warren, 195 Broadway, New York City, is chairman, and H. C. Sutton, 1401 Arch St., Philadelphia, Pa., is secretary. The Bureau of Standards undertook the investigation of certain phases of the electrolysis problem in 1910 and has since then made important contributions to the subject. At the beginning of the co-operative work between the bureau and the research sub-committee a policy was agreed upon to the effect that the investigations are solely concerned with the accumulation of facts leading to the establishment of principles upon which conclusions and recommendations may ultimately be based. Burton McCollum, of the bureau, has recently proposed an extended series of tests of samples of many kinds of pipe buried in the soils of known special character in selected localities in many parts of our country.

The Engineering Foundation is giving preliminary consideration to a study of that form of corrosion of iron which has been called "graphitic corrosion."

The American Electrochemical Society at its recent meeting named Dr. Colin G. Fink as head of the committee on corrosion investigations.

The Bureau of Mines at its Pittsburgh station is investigating the corrosion of mine waters on metals.

The American Society of Civil Engineers has recently appointed a research committee of which Prof. A. M. Talbot at the University of Illinois, Urbana, Ill., is chairman, and F. E. Schmitt, Associate Editor, *Engineering News-Record*, 10th Ave. at 36th St., New York City, is secretary. The matter of corrosion has not yet been considered by the committee, but undoubtedly will be.

Problems in Corrosion Pointed Out by Colin G. Fink

In a statement designed to co-ordinate the corrosion problems of immediate importance, Colin G. Fink, secretary of the National Research Council committee, calls attention to the widespread importance of work on this subject.

"In spite of the general relaxation in chemical and metallurgical research throughout the country," says Dr. Fink, "a number of the corrosion problems are so very important and their solutions involve such large savings in capital and labor that a number of concerns and government laboratories felt the urgent need of furthering corrosion research during the past year.

"The corrosion problems have been attacked from two more or less different angles. In the one case every effort is being made to arrest the corrosion of the materials now in use; in the second case, new materials are substituted and tried out. There are today a series of distinct corrosion problems, in each instance centered about some specific material or article of manufacture. There is, for example, the problem of the corrosion of food containers and the problem of the corrosion of buried conduits and cables. Besides these specific problems, there are the general investigations on the causes of corrosion under varying conditions and of various materials.

"We cite below a few of the corrosion problems covering specific materials or products; and secondly, a few of the general topics, closely allied to the corrosion problem, which require further study and research:

"Condenser tubes, underground cables, buried iron pipes, posts, etc., fence wire, flues, stacks, stovepipes, steel ships and ship fittings, roofing materials, mine pumps and other mine equipment, atmospheric corrosion of brass, atmospheric corrosion of bronzes, alloys resistant to high temperatures, corrosion of zinc cathodes, contact metals or alloys, catalyzer metals or alloys, cutlery steels, acid tank linings, corrosion of nickel-plated ware, boiler tubes and fireboxes, automobile radiators, insoluble anodes and the

corrosion of iron as effected by the presence of small amounts of other elements.

"General problems include the velocity of corrosion as effected by (*a*) temperature fluctuations, (*b*) alternate dry and moist surface, (*c*) presence of foreign materials, (*d*) presence of oxide or carbonate of one or the other constituent of the alloy, (*e*) crystal structure and intercrystalline cement; the properties of the surface film, (*a*) coefficient of expansion as compared with that of the underlying metal, (*b*) its chemical composition, (*c*) porosity, (*d*) flexibility or ductility, (*e*) coefficient of adhesion, (*f*) speed of renewal of 'healing,' (*g*) relative hardness, (*h*) how affected during mechanical working and finally the general problem of corrosion and bacteria.

Suggests Lines of Endeavor

"A more complete micrographic investigation of the changes taking place in the film and the metal underneath, during the process of corrosion, is very desirable. Furthermore, we shall be able to progress more rapidly the sooner we agree upon standard tests used to determine the relative corrodibility of two samples. At present it is almost impossible to compare the results of one author with those of another, even when both have used the same materials in their tests.

"Within the last year decided progress has been made in cutlery steels, in metals and alloys for mine equipment, in cable sheath, in insoluble anodes and in alloys resistant to high temperatures and the corrosive action of molten metals such as zinc, tin, etc. But the corrosion problem, as a whole, in spite of its long past history, is still in its 'infancy' and it is only through co-operative effort and a free discussion of results (those suitable for advertising purposes as well as those usually suppressed) that consistent forward strides are possible."

Trade Associations Invited to Co-operate

Some associations, like the National Canners' Association, and certain corporations, like the New Jersey Zinc Co. and National Tube Co., have been making studies in corrosion. The committee of the National Research Council will be very glad to be informed of any work on corrosion that is going on or that is in contemplation. Communications should be sent to Paul Moore, secretary, Division of Research Extension, National Research Council, 1701 Massachusetts Ave., Washington, D. C.

Ratification of Gas Treaty Brings Forth Views of Senators on Its Effectiveness

While no vote was cast against the ratification of the submarine and noxious gas treaty, the futility of such an agreement was pointed out with great clearness by Senator Wadsworth of New York. Senator Lodge, in his effort to justify the treaty, said among other things:

"Undoubtedly the number of deaths in this war arising from poisoned wells was very small. Is that a reason for restoring to general use the poisoning of wells which has been driven out of use simply by the effect of public opinion?

"This clause in this treaty is not expected to prevent the use of poison gases at present. It is expected to do something toward crystallizing the public opinion of the world against it, and trying to make that public opinion more effective. I am aware that the losses of life in this war from poison gases were less than those from high explosives and other weapons, but it hardly seems to me an argument to say that because you kill more men with shells, it is well to add another method of killing them.

"It was obvious to the conference that it is impossible to make regulations for the production or the use of these poison gases because they are made in the production of dyes and in all sorts of chemical materials.

"If the world is cursed with another such war, I dare say poison gases will be used again, but there is always the hope that the opinion of the world may be so crystallized that it will prevent it, as public opinion alone practically has prevented the poisoning of wells and the giving of no quarter to prisoners."

Senator Wadsworth declared that "no nation in its senses will dare refrain from developing gases in research." In the debate attention was called to the fact that Great Britain intends to experiment actively with gases, not with the idea of precipitating their use, but with the idea of being in readiness in case another country should use them. Senator Wadsworth pointed out that we are doing the same thing. In that connection he said:

"We cannot stop the development of gases. It will go on inevitably, to the end of time, in my humble judgment. I will not be surprised if chemical warfare, developed to its highest point of perfection, will make war infinitely more merciful than it is today. It is quite within the realm of possibility that gases will be developed which will put an entire opposing force out of action and yet not injure permanently a man in that force. Not only will development go on inevitably in industry—we could not stop it if we were to try—but every nation will endeavor, in the open or behind closed doors, to continue its research under governmental auspices. No nation will dare take a chance. Poison gases have proved too effective a weapon to be ignored. I should be much discouraged if the army of the United States ceases to experiment in the perfection of gas masks on account of this treaty. The only way to perfect a mask is to experiment with the gases, so the entire research cycle is involved.

"I know I am speaking in contradiction of a very well-defined public sentiment, but nevertheless I think I am justified in making these observations. Can any weapon which in a great war accounts for one-third of all the casualties be definitely and finally barred from use in the wars of the future? It is easy to declare prohibitions against the use of weapons in warfare. The same protest was made against gunpowder many generations ago. I am not enthusiastic about entering into declarations concerning which there is a very strong probability of violation."

Senator Hitchcock of Nebraska made this observation: "While I rather sympathize with the argument of the Senator from New York, I suggest that after all the use of poisonous gases is only in its infancy. If we permit the cultivation and development of the poison gas science, it may be a much more terrific and destructive element in the next war."

Fate of Chemical Warfare Service in Balance—General Staff Favors Continuation as Unit

Decision as to the War Department's policy in the matter of chemical warfare has been vested in a committee of the General Staff. General Fries has made an extended presentation of his views before the committee. In addition, documentary evidence has been submitted. It is believed that it has been established to the satisfaction of the committee that the Chemical Warfare Service should be maintained as a separate entity within the War Department.

The General Staff at one time was very averse to the establishment of a separate Chemical Warfare Service. There was a tendency to minimize the importance of gas in warfare. It is believed, however, that changing personnel, as well as actual developments, has resulted in a very different attitude. A recent poll of officers of the General Staff showed that twenty-two favor the continuance of Chemical Warfare as a separate service, while only two voted to fuse it with Ordnance.

The attention of the Senate Appropriations Committee has been called to the reduction from $1,500,000 to $500,000 in the appropriation for the Chemical Warfare Service during the next fiscal year. It is understood that the Senate committee will make a careful study of the situation. There is reason to entertain hope that the Senate will increase the item.

Consider Calcium Chloride as Dust Preventive

At a meeting in Washington on March 24 of a committee of the American Society for Testing Materials with officials of the Bureau of Public Roads of the Department of Agriculture, to revise specifications for highway materials, a sub-committee was appointed which considered specifications for the use of calcium chloride as a dust preventive on gravel roads.

Large Attendance Expected at New York Convention of Paper Associations

The forty-fifth annual convention of the American Paper and Pulp Association will take place at the Waldorf-Astoria, New York, the week beginning April 10. Several of the meetings of the affiliated associations have been tentatively scheduled, and there is every prospect of a record-breaking attendance.

The dates for the meeting of the American Paper and Pulp Association have been definitely fixed, while the meetings scheduled by the affiliated associations are tentative, but will probably be unchanged in most cases. The list as at present announced follows:

Tuesday, April 11—10 a.m., Glassine and Greaseproof Manufacturers; 10 a.m., Book Paper Manufacturers; 10:30 a.m., Salesmen's Association; 2 p.m., Vegetable Parchment Manufacturers; 2 p.m., Salesmen's Association; 7 p.m., annual banquet of the Salesmen's Association.

Wednesday, April 12—10 a.m., Waxed Paper Manufacturers; 10 a.m., Writing Paper Manufacturers; 2 p.m., Sulphite Bond Division.

Thursday, April 13—10:30 a.m., annual meeting, American Paper and Pulp Association; 7 p.m., annual banquet.

Friday, April 14—11 a.m., Toilet Paper Converters; 2:30 p.m., Tissue Paper Manufacturers; 6 p.m., Tissue Paper Manufacturers and Toilet Paper Converters Association annual dinner. The meetings on Friday are scheduled to take place at the Hotel Astor.

T.A.P.P.I. Program

The seventh annual meeting of the Technical Association will be held in conjunction with the meetings of the American Paper and Pulp Association. The contemplated arrangements are as follows:

Monday, April 10—Meetings of executive committee and standing committees.

Tuesday, April 11—First general session. Reports of officers and committees.

Wednesday, April 12—Second general session. Discussion of committee reports and special papers. Election of officers. Continuation of papers and discussions.

Thursday, April 13—General business meeting, American Paper and Pulp Association. Completion of T.A.P.P.I. program.

Progress of Molding Sand Research Work—Universities and Industries Co-operate

The committee on Molding Sand Research under the guidance of Division of Engineering, National Research Council and American Foundrymen's Association, has made progress in its program of research. The U. S. Geological Survey and the various State Geological Surveys have promised to co-operate with the sub-committee dealing with this phase of the work under the chairmanship of Professor H. Ries, of Cornell University. This sub-committee has prepared a letter of instructions to the State Geological Surveys, which will standardize methods of making the surveys of molding sand resources.

Work on standardization of tests is well under way. Questionnaires have been sent out to gather information on the present methods of testing physical properties of sand. A digest or replies to these questionnaires is expected to be available shortly.

Many firms and universities have offered to co-operate in the research work. Every endeavor will be made to maintain their interest and to assign problems to those universities and industrial laboratories offering to co-operate, due regard being given to the facilities and talent available. A list of research subjects has been compiled, which is given in part below.

1.—Recovery of used molding sand through restoring bond to the sand by subjecting it to contact with water vapor under high pressure.

2.—The effects of additions of certain chemical reagents upon the physical properties of clays and clayey materials, such as molding sand.

3.—Effects of water content on the bond and permeability of a molding sand.

4.—Effects of different water per cents in molding sand on the milling and drilling speeds of light gray iron castings.

5.—Research on fusion quality of facings (function of "peeler").

6.—Tests of various kinds of clays for restoring bond to molding sand.

7.—Comparison of lives of different molding sands.

8.—Effects on plasticity of bond in molding sand and reduction of water content when using oil.

9.—Effects of wet and dry storing of sand on bonding quality.

International Chemical Societies Plan Summer Meetings in France

The third international chemical conference will be held at Lyon, France, June 27 to July 2. At the second congress of the International Association of Pure and Applied Chemistry, the arrangements for the 1922 conference were delegated to the National Federated Chemical Societies of France. The committee of this organization in charge of the plans includes prominent city officials, business men and educators. The general program includes a reception to the delegates by the city of Lyon at the city hall, a number of general meetings, council and committee meetings and a banquet to the delegates given by the Chamber of Commerce of Lyon. A boat trip down the Rhone is also planned. Visits will be made to the silk mills and tanneries in the vicinity of Lyon and to the factories of Jonage.

The last excursions planned will bring the delegates to the vicinity of Marseilles in time to attend the second Congress of Industrial Chemistry to be held in that city July 2 to 7, in the headquarters of the Technical Institute. The arrangements for this meeting are in charge of a committee of prominent business men and industrial chemists of southern France. Among the subjects scheduled for discussion are studies of the mineral resources of the French colonies and studies of fatty acids, soaps, etc. A series of visits to industrial establishments near Marseilles will conclude the program.

International Engineering Conference to Be Held in Rio de Janeiro in September

Plans are being laid for an international engineering congress to be held in Rio de Janeiro in September, 1922, the occasion of the centenary of independence of Brazil.

It is understood that representative engineers from all the American countries will attend the congress and that the principal subjects of discussion will be:

1. The utilization of fuel resources.
2. The best utilization of water power.
3. Recent advances in irrigation methods.
4. The elimination of waste through the standardization of supplies for agricultural and industrial purposes.
5. Coal as a factor in industrial development.
6. Essentials of a national railroad policy.
7. Intercontinental engineering co-operation.
8. Port developments.
9. Terminal facilities.
10. The iron and steel industry.

Exhibition of Technical and Industrial Photography Proposed

A conference for a proposed exhibition of industrial and technical photography will be held in Room 109 of the Waldorf-Astoria Hotel, New York City, April 10, 1922. The meeting is being held during the convention of the American Pulp and Paper Association, as many of the members of that organization are interested in the subject in connection with photomicrographic studies of pulp and paper fibers.

No Interstate Commerce Commission Decision on Reduction of Rates Before April 15

The decision of the Interstate Commerce Commission in the matter of a general reduction in rates, it now appears, will not be forthcoming before April 15. At present the case is being studied by the commissioners individually. If they should find themselves in substantial accord, the decision probably could be handed down as early as April 15, but should there be important differences between them, the time required for the consideration of the case would obviously be extended.

Senate Finance Committee Votes to Extend Dye Embargo

By a vote of 6 to 4 the Senate Finance Committee decided to extend the dye embargo and licensing system for a period of 1 year from the date on which the tariff bill becomes a law. The dye embargo is now authorized under the emergency tariff bill enacted at the last session and continues in effect until a revised tariff bill is passed. At the end of the 1-year period the duties provided in the tariff bill will take effect unless the dyestuff and organic chemical producers are able to convince Congress that the embargo should be continued.

The bill at present provides for 7c. a pound and 50 per cent ad valorem on unfinished dyes and 7c. a pound and 60 per cent ad valorem on finished dyes.

In this connection, however, an emphatic protest has been lodged with the Senate Finance Committee by about 200 smaller manufacturers of synthetic organic chemicals against the extension of the embargo for 1 year only. Their position as communicated to the committee by Dr. S. Isermann is that while 1 year's extension might be helpful to companies with large capital, as they can afford to gamble on future protection, 1 year's extension does not place the smaller manufacturer in a position where he can procure capital to keep his business going.

Russian Engineers Request Technical Publications

The Engineering Section of the Society for Technical Aid to Soviet Russia has been requested by the Russian Scientific and Engineering Societies for contributions of books, bulletins, pamphlets and current literature on the scientific and industrial progress in the United States, particularly since 1914. Individual members of the Society have donated toward a fund created by the engineering group in order to send such literature to Russia. The demand, however, is so great and the needs for the latest available scientific and technical publications are so urgent for Russia's industrial rehabilitation that they cannot be filled by the Engineering Section of the S.T.A.S.R. It is requested that literature of this nature be forwarded to the Engineering Section of the Society for Technical Aid to Soviet Russia, at 110 West 40th St., New York City.

New Chemical Laboratory Is Planned for Tufts College

Bids have been taken for the erection of a new chemical laboratory building at Tufts College, Mass., and work will be commenced on the structure at an early date. The estimated cost has not as yet been announced. Rockwell & Wright, Tufts College, are architects.

Personal

Dr. F. W. Aston of Cambridge University, England, delivered an address on "Isotopes and the Structure of the Atom" before the joint meeting of the Washington Academy of Sciences, Philosophical Society of Washington and the Chemical Society of Washington, March 29, 1922.

William H. Bassett, technical superintendent and metallurgist of the American Brass Co., Waterbury, Conn., a subsidiary of the Anaconda Copper Mining Co., is making a tour of inspection with other officials of the company at the last-named company's properties at Butte, Anaconda and Great Falls, Mont.

A. P. Blackstead, formerly chief engineer of the Camden Iron Works (R. D. Wood & Co.), Camden, N. J., and prior to that hydraulic engineer with the Henry R. Worthington Co., New York, has joined the engineering staff of the Dayton Dowd Co., Quincy, Ill. Mr. Blackstead has recently returned from Europe, where he spent 6 months studying conditions and investigating recent developments in hydraulic engineering.

Dr. Robert P. Calvert addressed the Southern California Section of the American Chemical Society on March 30. He spoke on "The Manufacture of Celluloid and Motion Picture Films."

L. B. Kruse has been elected treasurer and assistant secretary of the Empire Iron Co., Philadelphia, Pa., operated under lease by the Cambria Steel Co., Widener Building, Philadelphia, Pa. P. B. Burtis has been elected secretary and assistant treasurer, succeeding D. B. Gehly, resigned.

Dr. Charles Skeele Palmer, consulting chemical engineer, of Pittsburgh, Pa., and formerly connected with the Mellon Institute, addressed the engineering students of the Carnegie Institute of Technology of Pittsburgh, on March 29, on "Faith in the Order of Nature—Invention Is a Part of It."

O. A. Pickett of the Hercules Powder Co. spoke on "Colloids and Some of Their Applications" before the senior class of the Cooper Union Night School on March 23.

Frederick W. Sperr, Jr., chief chemist of the Koppers Co., Pittsburgh, Pa., has been awarded the Beal medal by the American Gas Association, in recognition of his work and paper, presented at the convention of the organization last November, entitled "The Seaboard Liquid Process of Gas Purification."

A. A. Stevenson, vice-president in charge of manufacture of the Standard Steel Works Co., which is a subsidiary of the Baldwin Locomotive Works, has, at the request of Herbert C. Hoover, been designated a special representative of the American Engineering Standards Committee, to work with the Department of Commerce in the co-operation between the Department's Division of Simplified Practice and the American Engineering Standards Committee.

Dr. E. W. Washburn of the department of ceramics, University of Illinois, will lecture before the Franklin Institute, Philadelphia, on April 6, on the subject "Physical Chemistry and Ceramics."

Obituary

Dr. Theodor Liebisch, late professor of mineralogy at the University of Berlin, died at his home in Berlin, on Feb. 9 after a protracted illness. He was born on April 29, 1852, and from about 1890 to 1900 he was professor of mineralogy at the University of Göttingen. During this period there were very many Americans studying for their degrees in chemistry who took mineralogy under Prof. Liebisch. It is scarcely too much to say that he was one of the most highly respected and best loved professors in the university. He perhaps did more in a personal nature for the American students in those days than any other professor. All Americans respected and admired him for his deep learning, his ability as a teacher, his inspiration for research work and his extremely kind and ever thoughtful nature. About the year 1900 he was called to the University of Berlin; and served there until about 1920, when he retired from active work. He was the author of many books, his most important being "Grundriss der Physikalischen Krystallographie."

Market Conditions

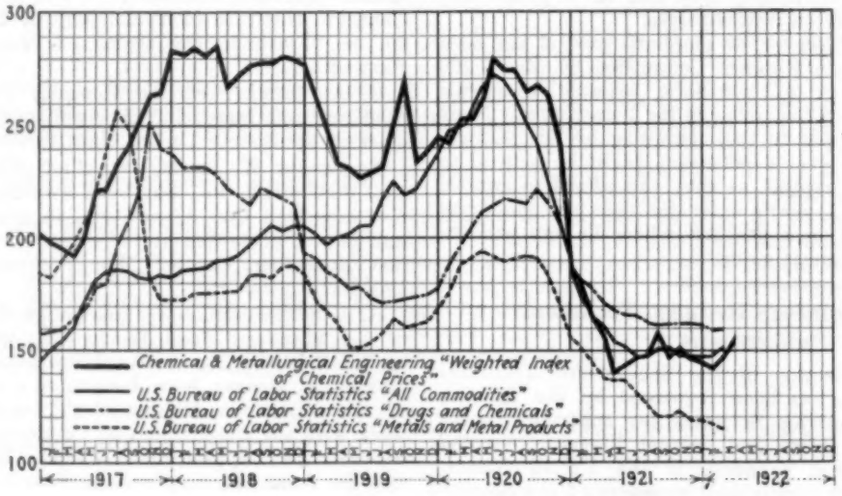
IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Business Progress During March

It is often said that the trend of business during the first 3 months of the calendar year affords a reliable index of conditions to be expected in the remaining three quarters. If this be the case, certainly there is much to justify the restoration of industrial confidence. The worst of the period of business readjustment is now so definitely behind us that current historians are already beginning to refer to the "memorable depression of 1921."

Many of the factors of improvement noted in the underlying business conditions in the early months of the year are becoming better defined and their influence on business is now more apparent. Among these factors, or the conditions directly attributable to them, are included the following: (1) The upward turn in certain commodity prices, notably farm products and foodstuffs, has not only increased the purchasing power of the farmer but has helped to close up the unduly wide spread between producer and consumer prices. (2) The larger volume of production, particularly in the iron and steel industry, but also noted in the manufacture of paper, petroleum, and other basic commodities, has materially lessened unemployment. (3) The strengthening advance in the stock market and the coincident easing up of money rates are signs of returning confidence in the future of business. (4) The recent increase in car loadings are indicative of greater industrial activity, especially as regards consumption and distribution. (5) The progress being made toward lower costs and increased efficiency promises a healthier form of competition.



COMPARISON OF WHOLESALE PRICES, 1917-1922

The only clouds on the business horizon are the difficult problems now being solved in the coal mines of the country and in the New England textile mills. The textile strike, although in progress for over 10 weeks, is still at a deadlock. The mill owners are meeting serious obstacles in their attempts to lower costs and to get their industry on a basis to compete with the Southern mills, where wage reductions have already been accepted. The coal strike, involving 600,000 men in both hard and soft coal mines, has not as yet caused a great deal of anxiety among our industrial leaders—in fact, many feel that if the general walkout had to come, there could have been no more appropriate time. The Geological Survey has announced that on March 1 the general industrial consumers had on hand an average coal reserve of 56 days, electric utilities 54 days, steel plants 48 days, railroads 42 days and byproduct coke ovens 39 days. It was officially estimated that the reserve on April 1 was 63 million tons and that production at the non-union bituminous mines of the country would continue at the rate of 4,700,000 tons per week.

Of the favorable factors listed in a previous paragraph, perhaps the one most welcomed by the manufacturer has been the gain in wholesale prices. That the chemical and related industries have participated in this upward movement is clearly shown in the accompanying chart. During the last 2 months the CHEM. & MET. index number has risen approximately 14 points and during the month of March has averaged 156.19, the highest quotation since August, 1921.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	156.75
Last week	157.65
April, 1917	207
April, 1918 (high)	286
April, 1920	261
April, 1921 (low)	140

This index number is based on the wholesale prices in the New York market for acetic acid, citric acid, hydrochloric acid, nitric acid, sulphuric acid, ethyl alcohol, methanol, anhydrous ammonia, ammonium sulphate, barium chloride, bleaching powder, borax, caustic potash, caustic soda, copper sulphate, formaldehyde, glycerine, potassium carbonate, saltcake, soda ash, crude sulphur, benzene, aniline oil, cottonseed oil and linseed oil.

THE FINANCIAL SITUATION

In the face of the adverse financial statements and the losses or lowered earnings noted in the annual reports of many companies, the stock market has maintained an unusually strong position. Since August of last year the *Annalist's* average for twenty-five industrials has shown an advance of 18 points. A similar average based on the stocks of twenty chemically controlled industries has also gained considerably during this period. From 46.1 on Aug. 1, 1921, this average rose to 59.0 on March 1. The ascent during the past month has continued, although at a somewhat slower rate. The increased activity in stocks can be attributed largely to the comparative ease in the money market. Call money in New York on March 18 got down to 2½ per cent, the lowest figure reached in recent years. Since then there has been a reaction, to be sure, and by the end of the month the rate was up to 4½@5 per cent. It is also interesting to record that on March 18 more separate stock issues were sold on the New York Stock Exchange during the day's business than on any other day in its history. For several days the number of shares handled exceeded a million.

A discussion of the financial market, however, is not complete without a reference to developments in the foreign exchanges. As the month started, sterling stood at the highest level since 1918. The quotation on March 1 was $4.44⅛. Toward the middle of the month and coincident with our demands on the Reparations Commission and the cessation of gold exports from London, the rate fell to $4.34. Since then there has been a slight recovery, bringing the value of the pound back to $4.37 on March 31. The sensation of the foreign exchange market, however, has been the sudden break in the German mark, which on March 27 had fallen to $0.0028⅛. This is the lowest quotation ever recorded for this currency and is generally believed to have resulted from the announcement of more stringent reparation policies on the part of the Allies.

The Chemical Market During the First Quarter of 1922

Developments of the first months of the current year have done much to encourage the growing feeling of optimism among the large producers and consumers of chemicals. The readjustments made throughout January were largely responsible for the general upward turn in prices which began in February and continued during the past month. The return to normal has not been entirely completed, but the process has left the chemical market in a much healthier condition than at any time in the past 2 years.

One of the outstanding features of the market during the last few months has been the recovery in the price of caustic soda—long regarded as the barometer of trading in the chemical industries. Domestic consumers, together with the foreign buyers, have forced the price of caustic from $3.25 per 100 lb. in February to $3.70 for 100 lb. in March. This has given an added impetus to the rest of the list, as may be noted from the accompanying tabulation of chemical prices. Large producers of caustic have been sold up until June, and in all probability the market will reach 4c. per lb. in the very near future. Other features have been the remarkable rise in barium chloride, prussiates of soda and potash, and sulphate of ammonia. Barium chloride opened the year at $52 per ton, recorded a decline in January to the extent of $4 per ton, but has steadily advanced since February from $50 to the present high level of $82 per ton for available spot material. Domestic producers are strongly of the belief that the market will reach $100 per ton before the summer months. Prussiate of soda has followed practically the same lines as barium chloride. Opening 1922 at 16½c. per lb., it recorded a steady advance throughout January and February. The first 2 weeks of March brought this commodity to a new high level of 18½c. per lb., but during the latter part of March the market declined slightly to 17c. per lb. Yellow prussiate of potash recorded a noteworthy advance since the beginning of the year. Opening at 23c. per lb., it continued to rise throughout the quarter and on March 31 was quoted at 26c. per lb. Stocks have gradually diminished on spot and imported goods have been difficult to locate. Domestic manufacturers report a sold-up condition for the next few months. It remained for the red prussiate, however, to show the greatest advance in the entire list. Prices quoted during the month of January were around 30c. per lb., but it has since become practically nominal, with only a barrel noted here and there at 70c. per lb. Dealers in sulphate of ammonia profited by large tonnage orders from Europe and Japan. The rise in this commodity did not take place until the latter part of February. It has since continued to advance, with quotations for limited supplies around $3.50 per 100 lb. Producers claim that the present market prices are not sufficient to net any substantial profits. There is no doubt that a higher market will be seen for this commodity in the near future. On the other hand, the quarter recorded a number of declines. Among them were formaldehyde, oxalic acid, glaubers salt, bleaching powder and cyanide of soda. In most cases these declines followed readjustments of costs, although some were the result of competition between domestic producers and importers. Bleaching powder manufacturers have also been hard pressed by importers, who have brought in large shipments of this material at extremely low figures. The result was that domestic bleach has declined since January to almost pre-war prices. The lower quotations for oxalic acid were the result of price-cutting among the domestic producers. This has caused a drop of 3c. per lb. since Jan. 1. Formaldehyde, cyanide of soda, fusel oil, granular zinc chloride, lead acetate, acetic acid and methanol were reduced by domestic manufacturers either to attract new business or to meet quotations on foreign materials.

A QUARTERLY REVIEW OF THE PRICES OF 45 IMPORTANT CHEMICALS, JANUARY–APRIL, 1922

Article	Unit	Price on Jan. 1	Average for Month of Jan.	Feb.	March	Price on April 1
Acetic acid, glacial	Lb.	$0.10	$0.10	$0.09	$0.09	$0.09
Muriatic acid, 20deg.	100 lb.	1.25	1.25	1.15	1.15	1.10
Nitric acid, 40 deg.	Lb.	.06½	.06½	.06½	.06½	.06
Oxalic acid	Lb.	.14½	.14	.14	.11½	.11½
Sulphuric acid, 66 deg.	Ton	17.00	16.50	16.00	16.00	17.00
Acetate of lead	Lb.	.10½	.10½	.10½	.09½	.09½
Ammonia alum, lump	Lb.	.03½	.03½	.03½	.03½	.03½
Aluminum sulphate, iron free	Lb.	.02½	.02½	.02½	.02½	.02½
Sal ammoniac, white gran	Lb.	.07	.06½	.06½	.07	.07½
Ammonium sulphate	Lb.	.02½	.02½	.02½	.03½	.03½
Amyl acetate	Gal.	2.40	2.00	2.00	2.00	2.00
Arsenic, white powd.	Lb.	.06	.07	.07½	.07½	.07
Barium chloride	Ton	52.00	50.00	56.00	75.00	80.00
Bleaching powder	100 lb.	2.50	2.25	2.10	1.75	1.60
Calcium acetate	100 lb.	1.75	1.75	1.75	1.75	1.75
Camphor	Lb.	.91	.90	.92	.90	.89
Copperas	Ton	15.00	15.00	15.00	15.00	15.00
Copper sulphate, crystals	100 lb.	5.65	5.65	5.60	5.55	5.55
Epsom salts, U.S.P.	100 lb.	2.65	2.65	2.65	2.60	2.50
Formaldehyde, 40%	Lb.	.10½	.10½	.10	.08½	.08½
Fusel oil, refined	Gal.	2.50	2.50	2.50	2.50	2.50
Glaubers salt	100 lb.	1.30	1.25	1.15	1.00	.95
Glycerine, c. p.	Lb.	.16	.16½	.16½	.16	.15½
Methanol, 95%	Gal.	.62	.61	.59	.58	.58
Nickel salt, single	Lb.	.14	.12	.11	.11	.11
Phosphorus, red	Lb.	.45	.45	.45	.45	.45
Potassium bichromate	Lb.	.10½	.10½	.10½	.10½	.10½
Potassium bromide, gran.	Lb.	.15	.14	.13½	.18	.17
Carbonate of potash, 80-85%	Lb.	.04½	.04½	.04½	.04½	.04½
Chlorate potash, crystals	Lb.	.06	.05½	.05½	.05½	.06½
Caustic potash, 88-92%	100 lb.	5.50	6.00	5.75	6.00	6.00
Permanganate of potash, U.S.P.	Lb.	.16	.14	.13½	.15	.15
Prussiate of potash, yellow	Lb.	.23	.25	.25	.26	.26
Salt cake, bulk	Ton	18.00	17.00	17.00	17.00	17.00
Soda ash, light, 58%	100 lb.	1.80	1.75	1.70	1.80	1.80
Bichromate of soda	Lb.	.07½	.07½	.07½	.07½	.07½
Fluoride of soda	Lb.	.11	.10½	.09½	.09½	.09½
Cyanide of soda	Lb.	.27	.26	.23½	.23½	.22½
Caustic soda, solid	100 lb.	3.75	3.70	3.35	3.65	3.65
Nitrate of soda	100 lb.	2.30	2.37½	2.37½	2.85	2.85
Prussiate of soda	Lb.	.16½	.17½	.18	.17½	.17
Sulphide of soda, 60%	Lb.	.04½	.04½	.04½	.04½	.04½
Sulphur, crude	Ton	18.00	18.00	18.00	18.00	18.00
Zinc chloride, gran.	Lb.	.09	.09	.09	.06	.05½
Zinc oxide, XX	Lb.	.07½	.07½	.07½	.07½	.07½

A QUARTERLY REVIEW OF THE PRICES OF COAL-TAR PRODUCTS, JANUARY–APRIL, 1922

Article	Unit	Price on Jan. 1	Average for Month of Jan.	Feb.	March	Price on April 1
Benzene, c.p.	Gal.	$0.29	$0.29	$0.29	$0.29	$0.29
Cresylic acid, 95-97%	Gal.	.65	.60	.45	.45	.45
Dip oil, 25%	Gal.	.31	.31	.27	.24½	.24
Solvent naphtha, water wh	Gal.	.25	.25	.25	.25	.25
Toluene, water white	Gal.	.30	.30	.30	.30	.30
Xylene, pure	Gal.	.40	.40	.40	.40	.40
H acid	Lb.	1.00	.97	.90	.85	.85
Phthalic anhydride	Lb.	.37	.37	.37	.35	.35
Salicylic acid, tech.	Lb.	.20	.20	.18	.20	.23
Alpha napthylamine	Lb.	.30	.28	.28	.30	.30
Aniline oil	Lb.	.17	.17½	.17	.16½	.16½
Aniline salt	Lb.	.25	.25	.24	.24	.24
Anthracene, 80%	Lb.	.75	.75	.75	.75	.75
Benzaldehyde, U.S.P.	Lb.	1.35	1.35	1.30	1.25	1.25
Benzoate of soda, U.S.P.	Lb.	.52	.52	.55	.55	.55
Benzidine, base	Lb.	.90	.85	.85	.85	.85
Benzidine, sulphate	Lb.	.75	.75	.75	.75	.75
Beta naphthol, tech.	Lb.	.30	.31	.29	.27½	.28
Dichlorbenzene	Lb.	.06	.06	.06	.06	.06
Dinitrobenzene	Lb.	.21	.21	.21	.22½	.23
Diethylaniline	Lb.	.90	.90	.95	1.12	1.15
Dimethylaniline	Lb.	.40	.40	.41	.38	.38
Dinitrophenol	Lb.	.38	.38	.35	.34	.33
Diphenylamine	Lb.	.60	.60	.60	.59	.59
Naphthalene, flake	Lb.	.07	.07	.06½	.06½	.06½
Naphthalene, ball	Lb.	.08½	.08	.07½	.07½	.08
Nitrobenzene	Lb.	.11	.10½	.10	.10	.10
Ortho-nitro-toluene	Lb.	.15	.15	.15	.13½	.12
Para-phenylenediamine	Lb.	1.65	1.60	1.55	1.50	1.50
Para-amidophenol, base	Lb.	1.30	1.25	1.25	1.25	1.25
Para-amidophenol, HCl	Lb.	1.55	1.45	1.35	1.30	1.30
Para-dichlorbenzene	Lb.	.15	.16½	.17	.15	.15
Paranitraniline	Lb.	.77	.77	.77	.75	.75
Phenol, U.S.P.	Lb.	.11½	.11½	.12	.11½	.11½
Resorcinol, tech.	Lb.	1.50	1.45	1.30	1.30	1.30
Toluidine, mixed	Lb.	.35	.32	.32	.32	.32

The New York Market

NEW YORK, April 2, 1922.

The general condition of the chemical market during the past week was fairly steady, although several dealers reported a slight improvement in the volume of business. Both advances and declines were noted in some of the more important items. Consumers have found some difficulty in obtaining certain chemicals, while for other commodities the market seemed oversupplied. The markets for barium chloride, caustic soda, sulphide of soda and sulphate of ammonia continued their recent activity and remained exceptionally strong. Caustic soda has attracted considerable attention. Consumers in Germany, Italy and Japan are sending inquiries for this material, and leading producers are quite firm in the belief that a much higher market will be seen in the very near future. Bleaching powder, on the other hand, has been somewhat notably weak. Barium chloride is maintaining its recent rise, with spot offerings relatively light.

GENERAL CHEMICALS

Barium Chloride.—Sellers quote the market exceedingly firm at $82 per ton on spot and $70 to arrive. Spot material is very scarce and dealers are not free in their offerings. Cables from abroad have been an important factor in the recent sharp advance.

Bichromate of Soda.—The market has shown very little signs of real live trading. Quotations are heard at 7¼@7¾c. per lb., according to quantity.

Caustic Potash.—The market for this product showed considerable strength early in the week, but later slackened because of lack of interest on the part of the consumers. Although most quotations were around 6c. per lb., odd lots were recorded down to $5.65 per 100 lb.

Caustic Soda.—No real change of any importance was heard in this item during the week and the general condition of the market was reported fair. Resale lots were quoted at $3.65 per 100 lb. f.a.s. N. Y., for March-April shipment. Some producers reported their entire output sold until June. Quotations at the works are unchanged at 2½c. per lb., basis 60 per cent, on contracts in carload lots.

Chlorate of Potash.—Imported goods were quoted somewhat higher by leading sellers and late in the week 6½c. per lb. was named as the general quotation. Some sales were recorded a fraction below this figure. Domestic chlorate remained unchanged at 8c. per lb., f.o.b. works.

Chlorate of Soda.—Imported material is held firm at 6¼@6¾c. per lb. Surplus stocks have disappeared to a noticeable extent and sellers are not eager to quote below these figures. Domestic quotations remain unchanged at 7c. per lb., f.o.b. works.

Bleaching Powder.—Another reduction was recorded in this item at producing quarters and first hands are quoting down to $1.60 per 100 lb., f.o.b. works, in large drums. Imported bleach is quoted at $1.85 per lb., ex-dock N. Y. The demand has not been active since large consumers covered their contract requirements.

Hydrochloric Acid.—A fair movement of this material into consuming channels is reported. Offerings, however, have been quite free of late. The best prices heard for the 18 deg. goods is $1.10 per 100 lb.

Sulphuric Acid.—There has been a decided change in this material among leading sellers and prices have been advanced to $17@$17.50 per ton for the 66 deg. goods in tank cars. The 60 deg. test is quoted at $11@$12 per ton. Contract requirements can be obtained at about $1 per ton under the regular quotations.

LINSEED OIL

Linseed Oil.—Following a decline in Argentine flaxseed, the market on linseed oil was easier. Crushers lowered prices to a basis of 78c. per gal. in carload lots. The inquiry for shipment oil over the next 3 months has improved, but buyers were unwilling to pay any high figures and little business was transacted. The tariff situation attracted a good deal of attention. It is believed that the new duty will be 3c. per lb., equal to 22c. per gal. Imported oil was offered at 71c. per gal. for English material, April shipment, duty paid.

The St. Louis Market

ST. LOUIS, March 30, 1922.

While some of the present activities in the heavy industrial chemical market could be traced directly to the fear of the impending coal strike, we do not believe this to be entirely responsible, but that depleted stocks, resumption of industrial activities, firmness of prices and restoration of confidence are primarily the influencing factors. Statistics indicate that all industries have made an appreciable increase in their operations, some to the extent of 25 to 50 per cent. Price changes have been very few, with declines in the minority, and in general prices are much firmer than they have been for many months. Further, the market is practically devoid of any depressing selling pressure. Heavy importations are still reported, but at greatly enhanced prices, due to the continued rise in exchange, thus showing no demoralizing effect upon the market.

ALKALIS

Caustic soda maintains the same price of 2 weeks ago and is moving in good volume to small buyers. Very little carload business being done. *Soda ash* is firm at $2.50 per 100 lb. in barrels and $2.30@$2.40 per 100 lb. in bags—this for less than carload lots. Carloads can be had for ¾c. under these prices. *Sodium bicarbonate* is moving slowly with no price variations. *Sal soda* is steady and in good demand at the prevailing price of last week.

GENERAL AND SPECIAL CHEMICALS

The *heavy mineral acid* market is no longer being disturbed by the weak holders, who some time ago were willing to unload at very little or nothing, consequently there has been better interest and firmer prices. Furthermore, the acid market has been greatly benefited by the increased operations of the steel mills and many other large industrial plants where acids are required. *Citric acid* has shown more life during the past few weeks with a firm market. *White arsenic* is now on the easier side and spot lots are quoted at 6@7½c. per lb., f.o.b. producer's works. *Benzene* is moving in good volume with the market in producers' hands. Ruling prices are 37@40c. per gal. *Bromides* are very firm with a good demand. *Carbon bisulphide* has been rather quiet, prices remaining the same. There has been no change in price of *carbon tetrachloride*, and trading did not deviate from the routine. While the *copperas* demand is still beyond production, conditions have eased to some extent owing to the fact that during the past 60 days the steel mills have been operating more extensively. Prices quoted by one manufacturer for granular in bulk are 90c. per 100 lb. by the carload, and for the *flour copperas* $1.80 per 100 lb. in carload lots and $1.90 per 100 lb. in less than carload lots, all prices f.o.b. producer's works. *Epsom salts* has firmed up considerably, prices ranging from $2.70@$2.87½ per 100 lb. for less than carload lots, supplier's warehouse. *Glycerine* has not changed in price, though the demand has slackened a bit and 16c. is being asked by all producers, but one or two transactions have been made recently at 15½c. *Sulphur* is moving in good volume and maintaining a good steady price. *Zinc sulphate technical* has been rather quiet since our last report, prices, however, prevailing the same.

VEGETABLE OILS AND NAVAL STORES

Castor oil retains its standing in the price list at 13½c. in drums, and a commission of 1c. is being made to customers purchasing quantities of 200 gal. or more. *Linseed oil* is quoted today at 84c. basis raw oil, a decline of 3c. since our last report. *Turpentine* is quoted at 89½c., a variation of ½c. since last report.

PAINT MATERIALS

Red oxides remain stable and in fairly good demand. *Whiting* ranges in price from $11@$15 per ton, depending on quality and brand. Domestic *lithopone* is moving in fair volume at 6½c. in preference to imported goods at 6c.

The *barytes* market is about $23 per ton for high-grade material.

The Iron and Steel Market

PITTSBURGH, March 31, 1922.

There is an upward swing in prices in the iron and steel industry, manifested by actual advances in market prices for some commodities and by a stiffening in others. The disposition among sellers to advance prices is general and the opportunity is embraced as rapidly as it presents itself. Among buyers a disposition to buy seems equally manifest.

Bars and shapes are now fairly quotable at 1.50c., against 1.40c. a week ago and 1.35c. about 3 weeks ago. A price of 1.50c. is not rigidly maintained, as some particularly desirable orders have been going at less, while small orders have brought 1.55c. and in occasional instances 1.60c.

Hoops and hot-rolled strips are up $2 a ton, being quite firm at 1.90c. Wire nails continue very firm at $2.40, while price concessions in tubular goods are less extensive.

Many of the sheet mills have in the past 10 days announced that on April 1 their prices would be advanced $3 a ton, to 3.15c. for black sheets, 4.15c. for galvanized and 4.50c. for automobile sheets. There seems to be no doubt that within a few days all makers will have advanced prices.

There is no uncertainty as to the amount of buying that has occurred, the rate of production, the prices, the volume of shipments or payment for the shipments made. The buying has been heavy, production of ingots has increased from a rate under 18,000,000 tons a year at the end of December to a rate of about 29,000,000 tons at the end of February and to a rate of probably 31,000,000 or 32,000,000 tons at the present time. Substantially all the steel made has been shipped. Prices have been firming up, with some advances, and more advances are probable.

UNCERTAINTY AS TO ACTUAL CONSUMPTION

These things are well established, yet there is uncertainty as to the future, whether demand and production will continue to increase or will soon begin to decrease. The uncertainty lies in the relation between steel received by buyers and steel passing into actual consumption. Experienced observers are a unit in declaring that ultimate consumption is well below the rate of producing and shipping. Perhaps the condition resembles that which has obtained at certain times in the past, when demand exceeded consumption through buyers replenishing stocks and afterward consumption rose so as to balance production, the increase in stocks having been necessary to provide facilities for jobbers and manufacturing consumers to conduct their business in an orderly and efficient manner.

A particular element of uncertainty is injected into the situation by the fact that at midnight tonight begins the coal-mining suspension. The suspension promises to be a very serious affair, yet the current estimates are that consumers of coal have well fortified themselves. If one assumes that buyers of steel have been influenced by the prospective mining suspension to lay in stocks of steel, then there is a possibility of demand decreasing once the suspension has begun.

Producers of steel are particularly keen to make the most of their limited opportunites in advancing prices. Before the war it was held that steel prices were unlikely to advance except with the steel industry operating at 80 or 85 per cent of its capacity. At 32,000,000 tons of ingots a year the nominal operating rate would be a trifle over 60 per cent, but counting out some capacity that cannot be reckoned when prices are so extremely low, the practical operating rate is probably nearer 70 per cent.

COKE AND PIG IRON

Connellsville coke has weakened somewhat, it being possible to pick up odd lots of spot furnace coke at $3.25, though for regular shipment over a week or two last week's price of $3.50 would probably have to be paid. Connellsville coal has gone to remarkably low levels, well below cost of production with the Frick scale. A number of operators have been paying less than the scale, and it is far from impossible that strikes will occur at such mines.

Pig iron shows a stronger tone, but with prices still quotable at $19.50 for bessemer, $18 for basic and $19 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being $1.96.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0 40 – $0 42
Acetone	lb.	$0 11½ – $0 12	.12½ – .12½
Acid, acetic, 28 per cent	100 lbs.	2 50 – 2 60	2 65 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9 00 – 9 50	9 75 – 10 00
Boric, crystals	lb.	.11 – .11½	.11½ – .12
Boric, powder	lb.	.11½ – .11½	.11½ – .12½
Citric	lb.	..... –	.46 – .46½
Hydrochloric	100 lb.	1 10 – 1 20	1 25 – 1 70
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11 – .12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½ – .05
Molybdic, c.p.	lb.	3 00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg.	lb.	.06 – .06½	.06½ – .07
Nitric, 42 deg.	lb.	.06½ – .06¾	.07 – .07½
Oxalic, crystals	lb.	.11½ – .12	.12½ – .13
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08½ – .09½
Picric	lb.	.23 – .25	.26 – .32
Pyrogallic, resublimed	lb.	..... –	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	11 00 – 12 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	17 00 – 17 50	..... – .....
Sulphuric, 66 deg., drums	ton	20 00 – 20 50	21 00 – 22 00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20 00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22 50	23 00 – 24 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32 00	33 00 – 34 00
Tannic, U. S. P.	lb.	..... –	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	..... –	.26½ – .28
Tartaric acid, imported, powdered	lb.	..... –	.27½ – .30
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1 00 – 1 10
Alcohol, ethyl	gal.	..... –	4 75 – 5 50
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.32 – .34
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.32 – .34
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03½ – .04	.04½ – .05
Alum, chrome lump	lb.	.07½ – .08	.08½ – .08¾
Aluminum sulphate, commercial	100 lb.	1 65 – 1 85	1 90 – 2 40
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30¼	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06½ – .07	.07½ – .07½
Amylacetate tech.	gal.	..... –	2 00 – 2 40
Arsenic, white, powdered	lb.	.07 – .07½	.07½ – .08
Arsenic, red, powdered	lb.	.12 – .12½	.12½ – .13
Barium chloride	ton	80 00 – 85 00	86 00 – 90 00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	.06½ – .07	.07½ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03½ – .04	.04½ – .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45 00 – 55 00	..... – .....
Bleaching powder	100 lb.	1 60 – 1 75	1 80 – 2 75
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05½ – .05¾	.06 – .06¼
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	1 75 – 2 00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	.01½ – .02	.02½ – .02½
Calcium peroxide	lb.	..... –	1 40 – 1 50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.89 – .91
Carbon bisulphide	lb.	.06 – .06½	.06½ – .07½
Carbon tetrachloride, drums	lb.	.09½ – .10	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04½ – .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03½	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06½ – .07
Chloroform	lb.	..... –	.37 – .40
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas	ton	15 00 – 16 00	16 50 – 30 00
Copper carbonate, green precipitate	lb.	.19 – .20	.20½ – .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	5 55 – 5 65	5 70 – 6 25
Cream of tartar	lb.	..... –	.23½ – .25
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.93 – 1 00
Formaldehyde, 40 per cent	lb.	.08½ – .09	.09½ – .10
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	..... – .....
Fullers earth–imported powdered–net	ton	30 00 – 32 00	..... – .....
Fusel oil, ref.	gal.	..... –	2 50 – 3 00
Fusel oil, crude	gal.	..... –	1 40 – 1 75
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.15½ – .16
Iodine, resublimed	lb.	..... –	4 05 – 4 15
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.09½ – .12
Lead arsenate, powd.	lb.	.14 – .14½	.14½ – .15½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07½ – .07½	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06½ – .08
Magnesium sulphate, U. S. P.	100 lb.	2 50 – 2 60	2 65 – 2 85
Magnesium sulphate, technical	100 lb.	..... –	1 60 – 1 80
Methanol, 95%	gal.	..... –	.57 – .58
Methanol, 97%	gal.	..... –	.59 – .60
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.11 – .11
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35

		Carlots	Less Carlots
Potassium bichromate	lb.	.10¼ - .10½	.10½ - .10¾
Potassium bromide, granular	lb.	..... -	.17 - .23
Potassium carbonate, U. S. P.	lb.	.12 - .12½	.13 - .16
Potassium carbonate, 80-85%	lb.	.04½ - .04¾	.05 - .06
Potassium chlorate, crystals	lb.	.06½ - .06¾	.07 - .08
Potassium cyanide	lb.	..... -	.42 - .45
Potassium hydroxide (caustic potash)	100 lb.	6.00 - 6.25	6.30 - 7.00
Potassium iodide	lb.	..... -	3.10 - 3.15
Potassium nitrate	lb.	.07½ - .07¾	.08 - .09
Potassium permanganate	lb.	.15 - .15½	.16 - .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	.26 - .26½	.26½ - .27
Rochelle salts (see sodium potas. tartrate)	....	..... -	..... - .....
Salammoniac, white, granular	lb.	.07½ - .07¾	.07¾ - .08
Salammoniac, gray, granular	lb.	.07½ - .07¾	.07¾ - .08
Salsoda	100 lb.	1.50 - 1.60	1.65 - 1.90
Salt cake (bulk)	ton	17.00 -20.00	..... - .....
Soda ash, light	100 lb.	1.80 - 2.00	2.05 - 2.60
Soda ash, dense	100 lb.	1.85 - 1.95	2.00 - 2.50
Sodium acetate	lb.	.04½ - .04¾	.04¾ - .05
Sodium bicarbonate	100 lb.	1.80 - 1.90	1.95 - 2.40
Sodium bichromate	lb.	.07½ - .07¾	.08 - .08½
Sodium bisulphate (nitre cake)	ton	4.50 - 4.60	4.65 - 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ - .04¾	.04¾ - .05½
Sodium chlorate	lb.	.06½ - .07	.07¼ - .07½
Sodium chloride	long ton	12.00 -13.00	..... - .....
Sodium cyanide	lb.	.22½ - .26	.26½ - .27½
Sodium fluoride	lb.	.09½ - .10	.10½ - .10¾
Sodium hydroxide (caustic soda)	100 lb.	3.65 - 3.70	3.75 - 4.25
Sodium hyposulphite	lb.	.03½ - .03¾	.03¾ - .04
Sodium nitrite	lb.	.08½ - .08¾	.09 - .09½
Sodium peroxide, powdered	lb.	.28 - .30	.31 - .35
Sodium phosphate, dibasic	lb.	.03¾ - .04	.04¼ - .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... -	.18 - .21
Sodium prussiate, yellow	lb.	.17 - .17½	.17½ - .17¾
Sodium silicate, solution (40 deg.)	100 lb.	.85 - 1.00	1.05 - 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.50 - 2.60	2.65 - 3.00
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.95 - 1.10	1.15 - 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¾ - .04¾	.04¾ - .05½
Sodium sulphite, crystals	lb.	.03½ - .03¾	.03¾ - .04¾
Strontium nitrate, powdered	lb.	.10 - .11	.11½ - .15
Sulphur chloride, yellow	lb.	.04½ - .05	.05½ - .06
Sulphur, crude	ton	18.00 -20.00	..... - .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour	100 lb.	..... -	2.25 - 3.10
Sulphur, roll (brimstone)	100 lb.	..... -	2.00 - 2.75
Talc—imported	ton	30.00 -40.00	..... - .....
Talc—domestic powdered	ton	18.00 -25.00	..... - .....
Tin bichloride	lb.	.09 - .09½	.09½ - .10
Tin oxide	lb.	..... -	.37 - .38
Zinc carbonate	lb.	.14 - .14½	.14½ - .15½
Zinc chloride, gran.	lb.	.05½ - .06	.06½ - .06¾
Zinc cyanide	lb.	.42 - .44	.45 - .47
Zinc oxide, XX	lb.	.07½ - .08	.08½ - .08¾
Zinc sulphate	100 lb.	2.75 - 3.00	3.05 - 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16½ — .17
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.28 — .30
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97-99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.15 — 1.20
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.23 — .25
Dinitroclorbenzene	lb.	.23 — .25
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Dipnenylamine	lb.	.59 — .70
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.14 — .15
Monoethylaniline	lb.	1.20 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.12 — .15
Ortho-toluidine	lb.	.16 — .20
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.15 — .18
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.35 — .38
Phenol, U. S. P., drums	lb.	.11½ — .15
Pyridine	gal.	1.75 — 2.75
Resorcinol, technical	lb.	1.30 — 1.35
Resorcinol, pure	lb.	1.75 — 1.80
Salicylic acid, tech., in bbls.	lb.	.23 — .24
Salicylic acid, U. S. P.	lb.	.25 — .26
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.10 — .12
Sulphanilic acid, crude	lb.	.25 — .27
Tolidine	lb.	1.20 — 1.30
Toluidine, mixed	lb.	.32 — .38
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.30 — .35
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — .....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — .....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 — $0.21
Beeswax, refined, dark	lb.	.26 — .28
Beeswax, refined, light	lb.	.30 — .32
Beeswax, white pure	lb.	.35 — .40
Candellila, wax	lb.	.25 — .26
Carnauba, No. 1	lb.	.45 — .46
Carnauba No. 2, North Country	lb.	.25 — .25½
Carnauba, No. 3, North Country	lb.	.16 — .16½
Japan	lb.	.17½ — .18
Montan, crude	lb.	.04½ — .04¾
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ — .04¾
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ — .....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 — .03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½ — .03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 — .04½
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ — .04¾
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 — .05½
Stearic acid, single pressed	lb.	.08½ — .09
Stearic acid, double pressed	lb.	.09½ — .09¾
Stearic acid, triple pressed	lb.	.10½ — .10¾

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.15 —	5.20
Rosin E-I	280 lb.	5.25 —	5.30
Rosin K-N	280 lb.	5.90 —	6.65
Rosin W. G.-W. W	280 lb.	7.00 —	7.25
Wood rosin, bbl	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	.86½ —	.87
Wood turpentine, steam dist	gal.	.84 —	.....
Wood turpentine, dest. dist	gal.	.68 —	.70
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	9.50
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	.....
Rosin oil, second run	gal.	.38 —	.....
Rosin oil, third run	gal.	.46 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y.	100 lb.	3.50 —	3.75
Blood, dried, f.o.b., N. Y.	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.85 —	2.87½
Tankage, high grade, f.o.b. Chicago	unit	3.25 —	3.40
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50 —	7.00
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	33.50 —	35.00
Potassium sulphate	unit	1.00 —	.....

Crude Rubber

Para—Upriver fine	lb.	$0.17½ —	.17¾
Upriver coarse	lb.	.12 —	.13
Upriver caucho ball	lb.	.12½ —	.13
Plantation—First latex crepe	lb.	.14½ —	.15
Ribbed smoked sheets	lb.	.14½ —	.15
Brown crepe, thin, clean	lb.	.13 —	.....
Amber crepe No. 1	lb.	.15 —	.....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10 —	$0.10½
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls.	lb.	.14 —	.14½
Coconut oil, Ceylon grade, in bbls	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls.	lb.	.09 —	.09½
Corn oil, crude, in bbls.	lb.	.11 —	.11½

Cottonseed oil, crude (f. o. b. mill)	lb.	.09½ —	.10
Cottonseed oil, summer yellow	lb.	.11½ —	.12
Cottonseed oil, winter yellow	lb.	.13½ —	.13½
Linseed oil, raw, car lots (domestic)	gal.	.78 —	.79
Linseed oil, raw, tank cars (domestic)	gal.	.74 —	.75
Linseed oil, in 5-bbl lots (domestic)	gal.	.81 —	.82
Olive oil, denatured	gal.	1 12 —	1.15
Palm, Lagos	lb.	.08 —	.08½
Palm, Niger	lb.	.06½ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10½
Peanut oil, refined, in bbls	lb.	.12½ —	.13
Rapeseed oil, refined in bbls	gal.	.85 —	.86
Rapeseed oil, blown, in bbls	gal.	.87 —	.88
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11 —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09½ —	....

FISH

Light pressed menhaden	gal.	$0 54 —	....
Yellow bleached menhaden	gal.	.57 —	....
White bleached menhaden	gal.	.56 —	....
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$800.00	$1,000.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	70.00 —	120.00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	12.50 —	17.50
Barytes, ground, white, f.o.b. mills	net ton	17.00 —	23.00
Barytes, ground, off color f.o.b. mills	net ton	13.00 —	21.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00 —	24.00
Barytes, crude f.o.b. mines	net ton	6.00 —	7.00
Casein	lb.	.10½ —	.12
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00 —	8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00 —	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00 —	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00 —	20.00
China clay (kaolin), imported, lump	net ton	14.00 —	20.00
China clay (kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, No. 1 pottery grade	long ton	6.50 —	6.75
Feldspar, No. 2 pottery grade	long ton	5.75 —	5.90
Feldspar, No. 1 soap grade	long ton	7.25 —	7.50
Feldspar, No. 1 Canadian, for mill	long ton	22.00 —	22.50
Graphite, Ceylon lump, first quality	lb.	.04½ —	.06½
Graphite, Ceylon chip	b.	.03½ —	.05
Graphite, high grade amorphous crude	lb.	.00½ —	.02½
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00 —	....
Kieselguhr, f.o.b. N. Y.	per ton	55.00 —	60.00
Magnesite, calcined (crude)	per ton	12.00 —	15.00
Pumice stone, imported	lb.	.03 —	.40
Pumice stone, domestic, lump	lb.	.05 —	.05½
Pumice stone, domestic, ground	lb.	.06 —	.07
Shellac, orange fine	lb.	.86 —	.87
Shellac, orange superfine	lb.	.88 —	.89
Shellac, A. C. garnet	lb.	.68 —	.69
Shellac, T. N.	lb.	.83 —	.84
Silica, glass sand, f.o.b. Indiana	per ton	1.25 —	1.50
Silica, sand blast material, f.o.b. Indiana	per ton	2.25 —	4.50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	14.00 —	14.50
Silica, building sand, f.o.b. Pa.	per ton	2.25 —	3.00
Soapstone	ton	12.00 —	15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00 —	12.00
Talc, 200 mesh, f.o.b. Georgia	ton	8.25 —	13.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00 —	20.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per 1,000	$130.00	
Carborundum refractory brick, 9-in.	1,000	1100.00	
Chrome brick, f.o.b. Eastern shipping points	net ton	41–44	
Chrome cement, 40-50% Cr_2O_3	net ton	30–32	
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	30–32	
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	32–37	
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	27–30	
Magnesite brick, 9-in. straight (f.o.b. works)	net ton	53–55	
Magnesite brick, 9-in. arches, wedges and keys	net ton	70	
Magnesite brick, soaps and splits	net ton	90	
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	35–37	
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	37–39	
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	27–30	

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6–8% carbon, carlots	lb.	.11 —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.11½ —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	62.50 —	....
Ferromanganese, 78-82% Mn, English and German c. i.f. Atlantic seaport	gross ton	59.00 —	62.50
Spiegeleisen, 18-22% Mn	gross ton	30.00 —	32.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2.25
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	54.00 —	55.00
Ferrosilicon, 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.37 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	3.55 —	3.75

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6.00 —	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	19.00 —	20.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	19.00 —	20.00
Coke, foundry, f.o.b. ovens	net ton	4.25 —	4.75
Coke, furnace, f.o.b. ovens	net ton	3.25 —	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.25½ —	.25½
Manganese ore, chemical (MnO_2)	net ton	55.00 —	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.40 —	.42
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.25 —	2.50
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	2.50 —	2.75
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	.....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13½

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.75
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	29.125
Lead, New York, spot	4.75
Lead, E. St. Louis, spot	4.425–4.50
Zinc, spot, New York	5.15
Zinc, spot, E. St. Louis	4.625–4.65

OTHER METALS

Silver (commercial)	oz.	$0.65½
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.15
Platinum	oz.	85.00@ 90.00
Iridium	oz.	160.00@170.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	50.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	19.25
Copper bottoms	27.75
Copper rods	19.25
High brass wire	16.75
High brass rods	14.25
Low brass wire	18.25
Low brass rods	18.75
Brazed brass tubing	23.00
Brazed bronze tubing	28.00
Seamless copper tubing	20.75
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	10.25@10.50
Copper, heavy and wire	10.00@10.25
Copper, light and bottoms	7.75@ 8.25
Lead, heavy	3.60@ 3.85
Lead, tea	3.00@ 3.25
Brass, heavy	4.50@ 4.75
Brass, light	4.00@ 4.25
No. 1 yellow brass turnings	4.00@ 4.25
Zinc	2.25@ 2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Chicago
Structural shapes	$2.63	$2.38
Soft steel bars	2.53	2.28
Soft steel bar shapes	2.53	2.28
Soft stee. bands	3.13	2.88
Plates, ¼ to 1 in. thick	2.63	2.38

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Industrial Developments

Rubber.—The Electric Hose & Rubber Co., Wilmington, Del., has added a night shift at its plant, giving employment to about 100 additional men.

The Rubber Production Co., Morgantown, W. Va., has reopened the local plant of the Armorcord Rubber Co., recently acquired under lease. The plant has been closed for about a year past.

The Hood Rubber Co., Watertown, Mass., has adopted a capacity operating schedule in the tire department at its local plant.

The Allen Tire & Rubber Co., Allentown, Pa., has adopted a 20-hour day schedule at its plant at Rittersville, Pa., adding a 10-hour shift, with additional employees, to the former production basis.

Glass.—The Macbeth-Evans Glass Co., Elwood, Ind., is arranging for the early resumption of operations at its local plant, and preparatory to production is rebuilding the No. 1 furnace, adding a new battery of lehrs and making other improvements to cost about $25,000.

The Henryetta Glass Mfg. Co., Henryetta, Okla., has commenced manufacture at 24 shops of its local plant, primarily for the production of lamp chimneys. Other departments will resume at an early date for the manufacture of tableware, lantern globes, etc.

The Interstate Window Glass Co., Kane, Pa., is increasing production at its Wheeling, W. Va., and Lancaster, O., plants.

Ceramic.—Practically all of the sanitary ware potteries at Trenton, N. J., are operating on a full-capacity basis.

The Acme Brick Co., Denton, Tex., has resumed operations at its plant, following a shut-down for several months past. Initial production will be on a basis of about 40,000 bricks per day, with employment of about 100 men.

Leather.—The American Hide & Leather Co., New York, N. Y., has resumed operations at full capacity at a number of its tanneries.

The Deford Tanning Co., Luray, Va., has resumed operations at its local plant, following a shut-down of a number of months.

Iron and Steel.—With the blowing in of the No. 1 blast furnace at the Carrie furnaces of the Homestead Steel Works, Homestead, Pa., March 22, seven of the eight furnaces at the plant are now in operation.

The Carnegie Steel Co. has resumed production at its Farrell (Pa.) works, which have been idle for about a year past. Two blast furnaces will be blown in early in April, and 11 open-hearth furnaces placed in service. Employment will be given to about 1,500 men. The company has blown in another furnace at its Isabella plant, Etna, Pa., and another stack will soon be placed in service at this works.

The American Sheet & Tin Plate Co., Cambridge, O., has started operations at the four remaining mills at its local plant, placing the works on a full operating basis for the first time since last November.

The Wheeling Steel & Iron Co., a subsidiary of the Wheeling Steel Corp., has adopted a 100 per cent operating schedule at its Benwood, O., plant.

The Republic Steel Co., Youngstown, O., is running full in the open-hearth department at its plant, including the entire battery of 14 furnaces.

The Youngstown Sheet & Tube Co., Youngstown, O., has blown in a fifth blast furnace at its local works, making but one idle stack at the plant. This will be placed in service at an early date.

The United States Steel Corp. has placed its Aetna-Standard plant, Aetnaville, O., on a 100 per cent operating basis.

Coke.—The H. C. Frick Coke Co. has fired 200 additional ovens at its Leith plant, near Greensburg, Pa., following a shut-down of more than a year.

Metals.—The Bartlesville Zinc Co., Blackwell, Okla., has resumed production at its smelting plant.

The American Smelting & Refining Co., New York, N.Y., will soon resume operations on a large scale at its smelting plant at El Paso, Tex., for the smelting of lead ores from the mines of the Erupcion Mining Co. and the Ahumada Lead Co., both of Chihuahua, Mexico, with which contracts have been made.

The Michigan Copper & Brass Co., Detroit, Mich., has adopted a 100 per cent operating schedule at its local plant, giving employment to about 800 men. A night shift is being operated until 9 o'clock every evening during the work-week.

Miscellaneous.—The Wilmington Fiber Specialty Co., New Castle, Del., is operating on a full production basis, with incoming orders in excess of capacity.

The Corn Products Co. has commenced operations at its plant at North Kansas City, Mo., recently completed at a cost of about $7,000,000. Employment will be given to 600 persons.

Construction and Operation

Arizona

GLOBE—The Magma Copper Co. has preliminary plans under way for the erection of a new smelting plant and copper mill. A bond issue of $4,000,000 is being arranged, a portion of which will be used for the project.

California

OAKLAND—The California Pottery Co. is perfecting plans for the removal of its local plant to Merced, Cal., where another plant is now being operated by the company. The latter works will be extended to accommodate the equipment from the Oakland plant, and 16 new kilns will be constructed. A complete general line of manufacture will be carried on, including firebrick, face brick, tile, sewer pipe, etc. Frank A. Costello is president.

INGLEWOOD—The Smoot-Holman Co., Los Angeles, comprising a recent reorganization of the American Enameling & Stamping Works of the same city, has acquired a tract of land at Inglewood, totaling about 5 acres, and has preliminary plans under way for the erection of a new plant, to consist of a number of 1-story buildings.

SELMA—The Fresno Tire & Rubber Co., Fresno, Cal., is arranging plans for the immediate erection of its proposed new local plant for the manufacture of tires and other rubber products. It will be 3-story, 60 x 250 ft. John S. Bates, Rowell Bldg., Fresno, is engineer.

COLTON—The Bach Reduction Co., Los Angeles, has acquired property at Colton, and plans for the erection of a new 1-story plant for the manufacture of fertilizer products.

Connecticut

HARTFORD—Fire, March 16, destroyed a portion of the auxiliary plant of the Johns-Pratt Co., manufacturer of compounds, etc., Homestead Ave. and Burton St., with loss estimated at about $15,000. The fire was caused by overheating or short-circuiting in a large enameling oven.

Florida

TAMPA—The Pineapple Products Co., Curry Bldg., recently organized with a capital of $50,000, is planning for the construction of a plant for the manufacture of fertilizer products, in connection with a new local factory for the production of syrups, phosphate, vinegar and kindred specialties. Henry O. Page is president; and William B. Hill, general manager.

Illinois

MT. VERNON—The Mount Vernon Car Mfg. Co. has awarded a contract to the Hughes-Foulkrod Co., Pittsburgh, Pa., for the construction of a 1-story foundry for the production of iron and other metal castings, 182 x 550 ft., estimated to cost about $250,000, including equipment. W. C. Archer is president.

WAUKEGAN—The Board of Works is having plans completed for the construction of a new filtration plant at the city waterworks, estimated to cost about $600,000, including pumping station. Hoad, Decker & Drury, 303 South State St., Ann Arbor, Mich., are consulting engineers.

Kentucky

PAINTSVILLE—The Paintsville Oil & Refining Co. will commence immediately the erection of a new topping plant, with extensive tankage department. A site has been selected near the city. Ralph Stafford heads the company.

Maryland

BALTIMORE—The Liberty Yeast Corp., 4400 O'Donnell St., will build a 1-story addition, 30 x 65 ft., to its ferment department. Equipment will be installed for the production of industrial alcohol. W. A. Boykin, Jr., is manager.

BALTIMORE—The Public Improvement Commission, City Hall, has plans under consideration for the establishment of a plant for the production of alum for the filter beds at the city waterworks, estimated to cost about $12,000. Robert Garrett is chairman.

Massachusetts

MITTENEAGUE—The Strathmore Paper Co. has awarded a contract to the Ernest F. Carlson Co., Springfield, Mass., for the erection of a 4-story addition to its plant, 25 x 200 ft. Work will be commenced at an early date.

SALEM—The Park Leather Co., Mason and Grove Sts., has commenced the enlargement of its plant. Equipment will be installed for increased capacity.

ASSONET—The New England Oil Refining Co., Purchase St., Fall River, Mass., has acquired property at Assonet, to be used as a site for the erection of a new distributing plant.

Michigan

HOLLAND—The De Pree Chemical Co. has awarded a contract to the Frank Dyke Co., Holland, for the erection of a 3-story addition to its plant, estimated to cost about $500,000, including equipment.

CADILLAC—The Cadillac Malleable Iron Co. has broken ground for the erection of a new 1-story foundry, 120 x 200 ft., and annealing building, 90 x 224 ft., for the production of iron and other metal castings. Additional units will be constructed at a later date. The Indiana Bridge Co., Muncie, Ind., has the building contract.

KALAMAZOO—The City Commission, C. L. Miller, city manager, has preliminary plans under way for the erection of a new municipal gas plant, comprising six buildings, estimated to cost in excess of $1,250,000. Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., are engineers.

MANISTEE—The Ruggles & Rademaker Co. is making rapid progress in the erection of its new local salt plant, and expects to have a portion of the works ready for service at an early date. The plant has been designed for a capacity of about 8,000 bbl. a day, or approximately 60 carloads, and will give employment to close to 300 men. It is estimated to cost approximately $2,000,000, complete. The company is an outgrowth of the Buckley & Douglas Lumber Co. salt plant, which was destroyed by fire about a year ago.

Missouri

JOPLIN—The Wilhoit Oil Co., Springfield, Mo., E. M. Wilhoit, president, is planning for extensions and improvements in its refinery at Joplin, estimated to cost about $100,000. The present plant will be remodeled.

New Jersey

ELIZABETH—Fire, March 22, destroyed a portion of the plant of the Atlantic Chemical Works, Bayway, near Elizabeth, with loss estimated at about $200,000, including equipment.

TRENTON—The Essential Oil Co., a subsidiary of the American Linseed Co., 297 4th Ave., New York, N. Y., has work under way on the remodeling of the local plant of the American Brass & Lamp Co., recently acquired, and plans to commence production early in June, giving employment to about 50 persons. The plant will be devoted to the manufacture of terpineol (synthetic lilac oil), camphor, terpin-hydrate and other volatile oils. Gustave Mahlck heads the company.

KEASBEY—Fire, March 21, destroyed a portion of the plant of the Carborundum Co., manufacturer of refractory products, saggers, etc., with loss estimated at about $50,000. The plant comprises the former works of the Didier-March Co. Headquarters of the company are at Niagara Falls, New York.

New York

BROOKLYN—Paul Uhlich & Co., 11 Cliff St., New York, N. Y., manufacturers of dry colors, etc., have filed plans for the rebuilding of the portion of their plant on Herkimer Place, Brooklyn, estimated to cost about $20,000.

ONEIDA—The Maxwell Steel Vault Co., 4 Warner St., has completed plans for the erection of the first unit of a new local plant, 1-story, 60 x 90 ft. Work will be commenced in April.

Oklahoma

COLLINSVILLE—The Collinsville Brick Co., has work under way for extensions and improvements in its plant. The capacity will be increased.

MUSKOGEE—The Muskogee Refining Co., South Cherokee St., is planning for extensions and improvements in its local refinery to cost about $200,000, including equipment.

Pennsylvania

PHILADELPHIA — The Continental Leather Co., 311 North 3rd St., recently organized under Delaware laws with a capital of $2,500,000, has acquired the former tanning plants of Janney & Burroughs, Inc., at a receiver's sale. The tanneries are located at Philadelphia, Augusta Springs and Elkton, Va., and will be placed in operation by the new owner at an early date. Perry E. Wurst, vice-president of the Alpena Leather Corp., Alpena, Mich., is president and general manager of the Continental company; Joseph Wayne, Jr., is vice-president and treasurer.

PHILADELPHIA — Montgomery Bros., Inc., 45 South 2nd St., manufacturer of rubber products, has filed plans for the erection of an addition to its plant at Packer and Penrose Sts.

PHILADELPHIA—The Wittman Moriarty Co., 4th and Vine Sts., manufacturer of leather, has taken title to property at B and Westmoreland Sts., 240 x 314 ft., for a consideration of about $30,000, and will commence the immediate erection of a new tanning plant on the site, 1- and 2-story, 77 x 105 ft., estimated to cost about $75,000.

WAYNESBORO—The Frick Co. will build a new foundry at its local agricultural implement plant, to be equipped for an output of about 60 tons of castings per day.

Tennessee

MEMPHIS—Fire, March 18, destroyed a portion of the oil plant of the Royal Refining Co., Hollywood, a suburb of Memphis. An official statement regarding the amount of estimated loss has not been made.

Texas

DALLAS—The Daniels' Chemical Proof Ink & Paper Co., 2212 Live Oak St., is planning for the erection of a new plant for the manufacture of chemical-proof ink products.

HOUSTON—The Humble Oil & Refining Co. is planning for the rebuilding of its tankage plant, destroyed by fire, March 21, with loss estimated at about $500,000

DALLAS—The Trinity Paper Mills Co., 3010 Williams St., has acquired a local site and plans to erect a new plant for the manufacture of waxed papers. J. Y. Webb is president.

Virginia

NORFOLK—The Robertson Chemical Corp., Board of Trade Bldg., is perfecting plans for the rebuilding of its plant in the Money Point section, recently destroyed by fire. It will be 1-story, 75 x 300 ft., and is estimated to cost about $60,000. W. H. Robertson is president.

CHATHAM—The City Council is planning for the installation of a filtration plant at the waterworks. A bond issue of $20,000 is being arranged.

West Virginia

HUNTINGTON—The Liberty Airless Tire Co., Parkersburg, W. Va., C. Lewis Wilson, president, is considering the erection of a new plant for the manufacture of automobile tires at Huntington. Negotiations are said to be under way for a local site.

GRAFTON—The City Council is planning for the installation of a filtration plant at the waterworks. Bonds for $100,000 will be voted.

Capital Increases, Etc.

THE OCEAN LEATHER CO., 40 Beaver St., New York, N. Y., has filed notice of increase in capital from $41,000,000 to $41,750,000.

THE COLAC CHEMICAL CO., Glens Falls, N. Y., has filed notice of increase in capital from $25,000 to $300,000.

THE CONTINUOUS CASTING CORP., Garwood, N. J., has filed an involuntary petition in bankruptcy.

THE MICHIGAN PORCELAIN INSULATOR CO., Hastings, Mich., has filed notice of dissolution under state laws.

WERBELOVSKY BROS., INC., 1160 Flushing Ave., Brooklyn, N. Y., manufacturer of glass products, has filed notice of increase in capital from $200,000 to $300,000.

THE STAR VARNISH WORKS, INC., Hamtramck, Mich., has filed notice of dissolution under state laws.

THE MINER EDGAR CO., Blanchard St., Newark, N. J., manufacturer of chemicals, refined clays, etc., has arranged for a bond issue of $1,000,000.

H. Snowden Marshall and Arthur J. Stevens have been appointed receivers in equity for the ISLAND OIL & TRANSPORT CORP., 55 Liberty St., New York, N. Y.

The General Oil Co., Houston, Tex., has been reorganized as the GENERAL PETROLEUM CO., with a capital of 11,000,000 shares of preferred stock and 1,000,000 shares of common stock, no par value.

THE E. I. DU PONT DE NEMOURS EXPORT CO., 120 Broadway, New York, N. Y., a subsidiary of E. I. du Pont de Nemours & Co., Wilmington, Del., has been dissolved, effective March 31.

New Companies

THE PULP PRODUCTS CO., 405 East Main St., Kalamazoo, Mich., has been incorporated with a capital of $100,000, to manufacture paper pulp and byproducts. The incorporators are Charles E. Taylor, Rossville, Ill.; George C. McCann, Danville, Ill.; and John E. Carey, Otsego, Mich.

THE CORAL CHEMICAL CO., Buffalo, N. Y., has been incorporated with a capital of $60,000, to manufacture chemicals and chemical byproducts. The incorporators are G. D. Fogarty, R. H. Robinson and J. T. Penfield. The company is represented by Stephen V. O'Gorman, Mutual Life Bldg., Buffalo.

THE MEDUSA CEMENT PAINT CO., Augusta, Me., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture special cement paints and affiliated products. E. M. Leavitt is president and treasurer; Frank E. Southard, Augusta, represents the company.

THE BLUE GRASS REFINING & PRODUCING CO., Lexington, Ky, has been incorporated with a capital of $50,000, to manufacture refined petroleum products. The incorporators are A. V. Smith, Jr., Walter R. Powell and J. F. Whorton, all of Lexington.

THE SWEDISH CHARCOAL STEEL PRODUCERS, INC., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture steel products. The incorporators are F. Sandelin, W. L. Batt and J. A. Vaughan, New York. The company is represented by F. J. Knorr, Albany, N. Y.

THE CAVE CITY OIL CO., 133 West Washington St., Chicago, Ill., has been incorporated with a capital of $30,000, to manufacture oil products. The incorporators are Edward M. Craig, Irl G. Hipsley and William H. Craig.

THE KONIKOW CHEMICAL LABORATORIES, Boston, Mass., have filed notice of organization to manufacture chemical products. The company is headed by William M. Kent, 52 Chamber St., Boston.

THE ARTCRAFT BRONZE CO., Detroit, Mich., has been incorporated with a capital of $20,000, to manufacture bronze and brass products. The incorporators are George B. Wood, George D. Ostergren and John M. Motschall, 1497 East Grand Boulevard, Detroit.

THE E. L. SMITH OIL CO., Wilmington, Del., has been incorporated under state laws with a capital of $5,000,000, to manufacture petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

LYNN & CO., INC., Syracuse, N. Y., has been incorporated with a capital of $10,000, to manufacture soaps and kindred products. The incorporators are J. Lindner, H. J. Wilson and A. V. Moliski. The company is represented by Gerber & Winkelstein, Syracuse.

THE HAMILTON OIL CO., Orange, Tex., has been incorporated with a capital of $5,000,000, to manufacture petroleum products. The company will succeed to the business of the Oil Issue Co. W. R. Hamilton is president; H. P. Ingles, first vice-president; and James N. Kincaid, secretary.

THE STATE FERTILIZER CO., Claremont Hotel, Union Stock Yards, Baltimore, Md., has been incorporated with a capital of $50,000, to manufacture fertilizer products. The incorporators are John W. Dasher, Robert S. Collier and J. Bradley Zepp.

THE AMERICAN INDUSTRIAL ALCOHOL CO., Jersey City, N. J., has been incorporated with a capital of $100,000, to manufacture industrial alcohol products and kindred specialties. The incorporators are William K. Faber and Francis Covner, 15 Exchange Pl., Jersey City.

THE FIDELITY RUBBER CO., New York, N. Y., has been incorporated under Delaware laws, with a capital of $250,000, to manufacture rubber products. The incorporators are E. E. and C. R. Allison, New York; and A. K. Dohrmann, Jersey City, N. J. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE HARBOR TANNING CO., Lynn, Mass., has been incorporated with a capital of $10,000, to manufacture leather products. Manuel Ross is president; and Arthur C. Stewart, Medford, Mass., is treasurer.

THE FLAXO CO., Saginaw, Mich., has been incorporated with a capital of $25,000, to manufacture chemicals, chemical compounds and affiliated products. The incorporators are Louis Kuehl, Saginaw; and Philip Catsman, Flint, Mich.

THE PENN-JERSEY FOUNDRY CORP., Camden, N. J., has been incorporated with a capital of $100,000, to manufacture iron, steel and other metal castings. The company is represented by the Corporation Trust Co., 328 Market St., Camden, N. J.

THE KINGSTON OIL CO., Kingston, N. Y., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are P. A. Black, J. P. Mack and M. H. Herzog, Kingston. The company is represented by Fowler & Loughran, 293 Wall St., Kingston.

THE UTILITY RUBBER CO., New York, N. Y., has been incorporated under Delaware laws, with capital of $1,000,000, to manufacture automobile tires and other rubber goods. The incorporators are Guy E. Norwood, New York; F. Haskell Smith, Bloomfield, N. J.; and James H. Coghill, Morristown, N. J. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE NEWARK COLOR & DYE WORKS, INC., Newark, N. J., has been incorporated with a capital of $100,000, to manufacture chemicals, colors, etc. The incorporators are Irving Rauchberg, Mordecai Segal and Samuel M. Hollander, 790 Broad St., Newark, N. J.

THE GAST-O-PINE CORP., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture chemicals and affiliated products. The incorporators are M. Gast, W. S. Rising and W. C. Cartwright, New York. The company is represented by H. S. Goodspeed, 522 Fifth Ave., New York.

THE GRAND RAPIDS CLAY PRODUCTS CO., Grand Rapids, Mich., has been incorporated with a capital of $25,000, to manufacture brick, hollow tile and other burned clay products. The incorporators are Isaac M. Hamilton, W. E. Brimstin and O. E. Merley, 168 North Michigan Ave., Chicago, Ill.

THE UNITED STATES WAXED & COATED PAPER CO., East Orange, N. J., has been incorporated with a capital of $50,000, to manufacture waxed and other special papers. The incorporators are Colin G. Fink, Walter E. Koerner and Oscar J. V. Aschenbach, 227 Elmwood Ave., East Orange.

THE WEST POINT SHALE BRICK CO., Norristown, Pa., has been incorporated under Delaware laws, with capital of $100,000, to manufacture brick and other burned clay products. The incorporators are George Wagner, Norristown; S. Swigler, Lansdowne, Pa.; and M. M. Sweeney, Philadelphia, Pa. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE LUBRICO OIL REFINING CO., Indianapolis, Ind., has been incorporated with a capital of $50,000, to manufacture refined petroleum products. The incorporators are W. S., R. F., J. T. and Fletcher Johnson, all of Indianapolis.

THE USONA BIO-CHEM LABORATORIES, INC., Wilmington, Del., has been chartered under state laws, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE DUNN-GRENET OIL CO., Pittsburgh, Pa., has been organized under state laws

by P. H. McGuire, W. F. Campbell and V. P. Keefe, Pittsburgh, to manufacture petroleum products. The company is represented by Russell J. Esler, 811 Frick Bldg., Pittsburgh.

THE BLOCHEM LABORATORIES, INC., Brooklyn, N. Y., has been incorporated with a capital of $5,000, to manufacture chemicals, industrial alcohol and kindred products. The incorporators are J. E. Gauthier, A. E. Daub and H. Whyman. The company is represented by David Geiger, 286 5th Ave., New York, N. Y.

THE METROPOLITAN CHEMICAL & NOVELTY CO., Philadelphia, Pa., has been incorporated under Delaware laws, with capital of $500,000, to manufacture chemicals and affiliated products. The company is represented by the Corporation Guarantee & Trust Co., Land Title Bldg., Philadelphia.

THE FIBRO CHEMICAL CO., Boston, Mass., has filed notice of organization to manufacture chemicals and chemical byproducts. The company is headed by E. V. Little, 113 Lincoln St., Boston.

THE GRAYCE OIL CO., Wichita Falls, Tex., has been incorporated with a capital of $150,000, to manufacture petroleum products. The incorporators are W. K. and S. J. Campbell and Carl Pursel, all of Wichita Falls.

THE CENTRAL PERU COPPER CO., New York, N. Y., has been incorporated with a capital of $100,000, under Delaware laws, to operate a copper smelting and refining works. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE ANSON BRICK & TILE CO., Lilesville, N. C., has been incorporated with a capital of $30,000, to manufacture brick, tile and other burned clay products. The incorporators are S. H. Clark, B. R. Wall, both of Lilesville; and C. P. Stewart, Pee Dee, N. C.

THE RANDOLPH MICA DEVELOPMENT CO., Birmingham, Ala., has been incorporated under Delaware laws, with capital of $150,000, to operate mica properties and manufacture mica products. The incorporators are Glenn S. Matthews, W. Alfred Gillespie and Andrew C. Roberts, all of Birmingham. The company is represented by the Corporation Service Co., Wilmington, Del.

Manufacturers' Catalogs

THE BINKS SPRAY EQUIPMENT CO., Chicago, Ill., has ready for distribution a short bulletin, No. 4-C, illustrating and describing the Binks spray tower, a water-cooling device suitable for small ice machines, oil engines, water-cooled electrical transformers and other apparatus requiring the cooling of small quantities of circulating water.

THE STEERS ENGINEERING CO., Detroit, Mich., is issuing a sheet on "Use Direct Condensation."

JOSEPH T. RYERSON & SON, Chicago, Ill., has added the magazine feature to its stock list, which will be known as the *Ryerson Journal and Stock List*. The list was formerly published monthly, but will now be published bi-monthly. The January-February issue contains a 30-page magazine section, increased space for new steel products and a section on small tools and machinery.

THE BOWKER INSECTICIDE CO., 49 Chambers St., New York, announces, in a 4-page folder, the establishment of a field service division and of a research chemical division. Dr. M. D. Leonard is director of the field service division and Firman Thompson is director of the research chemical division.

THE DESCHANEL ENGINEERING CORP., New York, N. Y., in an 8-page booklet illustrates and describes Deschanel cableway, hoists and buckets.

THE KAY MFG. CO., Norwalk, Conn., calls attention to its new bulletin entitled "Whitney Free Floating Coupling," which is designed to transmit power from one shaft to another, though the shafts are not in alignment, without causing strains in the shafts or bearings. Disassembled couplings are shown, dimensions are given and also a price list.

THE JEFFREY MFG. CO., Columbus, O., has issued three new catalogs. In Catalog 345, on coal and ashes handling machinery, twelve distinctive type of power house equipments are illustrated and described. Catalog 359 features the Jeffrey single roll crusher. This crusher, which is built in five sizes ranging from 18 x 18 in. to 36 x 54 in. is especially adapted for the power house, to insure a constant supply of stoker or small coal where stock sizes cannot always be obtained direct from mines and only run-of-mine or lump coal is available; or for the coaling station, to reduce run-of-mine and lump coal to proper firing sizes; or for the coal mine to reduce lump coal to small sizes to meet the demand for a uniform stoker coal and to dispose of surplus lump coal. Besides crushing coal the crusher lends itself to the reduction of salt, alum, bone and similar substances. The catalog illustrates and describes the construction and operation of the crusher, including typical installation in service, table of capacities of the different sizes of machines for use in crushing various grades of bituminous coal, and other information for crusher users. Bulletin 360 features the Jeffrey portable car unloader for unloading coal from hopper-bottom or gondola types of railroad cars. It is designed to enable it to meet various conditions of unloading. It requires a minimum of space and can readily be placed in between the car hopper door and the rails, or, where conditions permit, a more permanent arrangement can be had by placing the unloader underneath the rails and thus eliminate the necessity of resetting it for each car.

THE OLIVER-SHERWOOD CO., San Francisco, Cal., a subsidiary of the Oliver Continuous Filter Co., has issued a new catalog on "Cutless Bearings." Illustrations are given as well as a description of the weak link in every pump, the secret of the cutless bearing, the elimination of expense of machining, the many uses of cutless bearings and a list of pump manufacturers using the bearings.

THE NORTON CO., Worcester, Mass., in a 40-page booklet, illustrates and describes "Alundum Safety Tile," which is for stair treads, floors, ramps, elevator landings, entrances to public buildings or wherever a slip-proof, non-wearing surface is desired. Illustrations and descriptions are given on materials and process of manufacture, its advantages, general characteristic of physical properties, types and sizes and specifications for the proper installation of alundum safety tile. Interesting illustrations are given of the actual use of this tile in buildings, subways, stairs, floors, etc.

THE FULTON FOUNDRY & MACHINE CO., Cleveland, O., describes the Airedale clutch in a bulletin just issued. This clutch is made for services from 6 to 560 hp. in standard sizes, and is applicable for a wide range of machines in many kinds of industries. The clutch will not "grab," but picks up gently and is simple and ruggedly made.

THE MERRILL CO., San Francisco, Cal., announces its new catalog, "Merco Processes and Products." Descriptions are given of the Merco precipitation processes and products and also some of the up-to-date results achieved by representative installations, as well as descriptions of the Crowe vacuum-zinc shavings process, Merrill sluicing clarifying filter, Merco-Nordstrom plug valve, Merrillite and Merco methods for clarifying and precipitating cyanide solutions.

THE PHILADELPHIA DRYING MACHINERY CO., Philadelphia, Pa., has recently issued a 4-page folder which describes the various type of "Hurricane" driers for chemicals, battery plates, pharmaceuticals, electrical porcelain, leather, tobacco, spark plugs, food products, etc. The truck tray drier is described as well as the storage battery plate drier, the tunnel truck driers, automatic conveyor type of drier, cabinet tray drier, continuous sectional conveyor drier and "Hurricane" automatic combination stick and apron tobacco drier.

THE WELLMAN-SEAVER-MORGAN CO., Cleveland, O., has issued Bulletin 71 descriptive of the application of labor-saving machinery, particularly car dumpers, excavators, filling bridges and excavating bridges. It also describes the practical method of working very low-grade ore, especially by the leaching process.

THE COLORADO IRON WORKS CO. has issued Pamphlet 33, on "The Akins Flotation and Aeration Machine."

THE AMERICAN STEAM GAUGE & VALVE MFG. CO., of Boston, Mass., is distributing a folder describing its recording thermometer which has recently made its appearance on the market. This new product is actuated by different methods, depending on the purpose, and either saturated vapor expansion, inert gas or liquid is employed. It is in a 10-in. moisture-proof case to record any temperature up to 1,000 deg. F. at any distance up to 200 ft.

THE UEHLING INSTRUMENT CO., Paterson, N. J., announces two new publications: Bulletin 220, on "Magnitude of the Power Plant's Chimney Loss" and Bulletin 221, on "Relation Between CO_2 and Money Wasted Up the Chimney."

THE NASH ENGINEERING CO., South Norwalk, Conn., calls attention to Bull. 18, on "The Jennings Hytor Vacuum Heating Pump, Steam Turbine Driven," for return line heating systems, drier exhaust in paper mills and other vacuum work where liquid is handled with a gas. The booklet is printed in colors.

THE DORR CO., engineer, of New York, has just published an unusually attractive booklet entitled "Testing That Pays Dividends." It describes the laboratories and testing plant housed in the Westport mill at Westport, Conn., and discloses the philosophy of investigation and research into industrial processes. Individuals or companies confronted with the problem of replacing old processes or developing new ones will find much of interest and profit in the bulletin, a copy of which will be sent on request.

THE WHITLOCK COIL PIPE CO., Hartford, Conn., in Bulletin 30, describes the Whitlock all steel superheater, which represents a comparatively recent addition to the line of heat exchange apparatus manufactured by this company.

THE THWING INSTRUMENT CO., Philadelphia, Pa., in a recent bulletin, No. 10, illustrates and describes Thwing thermo-electric pyrometers, indicating and multiple-recording types.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., May 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15 to 22.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the third Monday of April, instead of the second Monday as usual.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY and the AMERICAN PULP AND PAPER ASSOCIATION will hold annual meetings at the Waldorf-Astoria, New York, the week of April 10.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.